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MOVEMENT OF BEACH MATERIALS ON THE EAST COAST OF ENGLAND

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Introduction

During the last decade a considerable amount of experimental work has been carried out on the movement of material alongshore and over the sea bed. New techniques, including the marking of silt, sand and shingle with radioactive and fluorescent tracers, have provided information of great value in the vital zone below low water. While the new methods have been tried the world over, much of the pioneering work, particularly with radioactive tracers, was carried out in this country. Many of the early experiments were sited on the East Coast, and it seems appropriate, therefore, to examine anew some coastal problems in this area in the light of the new evidence thus supplied.

Some East Coast Problems

The East Coast between Flamborough Head and the Thames, apart from the Wash and the Humber Estuary, is generally held to be an eroding coast. The relatively non-resistant Mesozoic rocks and the still less resistant glacial drifts that are exposed along this coast yield readily to wave attack. Yet erosion is not universal. While the Holderness area and the east coast of Norfolk and Suffolk have retreated rapidly before the attacks of the sea, the Lincolnshire coast has remained relatively stable and the north coast of Norfolk has been the site of great accumulations of silt, sand and shingle in the form of salt marsh, dune and spit. Between Aldeburgh in Suffolk and Harwich in Essex vast spreads of shingle occur. Figure 1 includes a generalised picture of the incidence of erosion and accretion south of the Humber. It should be stressed, however, that such generalisations mask variation in detail. Thus Winterton Ness is a depositional feature on an eroding coast, and the broad general stability of the Lincolnshire coast is marred by erosion locally, for example at Ingoldmells. Broadly the basic problems of the East Coast can be simply stated. What happens to the enormous quantities of material eroded from these shores? Where do the massive accumulations of the north Norfolk coast and of features such as Orfordness come from? Finally, how does all this material move from its place of origin to points of temporary or permanent deposition? All these are aspects of the same problem, but the simple obvious equation of losses on one part of the coast with gains on another proves to be not quite so simple when the processes involved are examined in detail. In a short paper an exhaustive treatment of so large a subject is not possible. However, it is proposed to examine one facet of the problem—the origins of the north Norfolk accumulations. To do this it will be necessary to touch on many other aspects and to refer to all parts of the East Coast. In so doing, the general implications of recent research will be made plain.

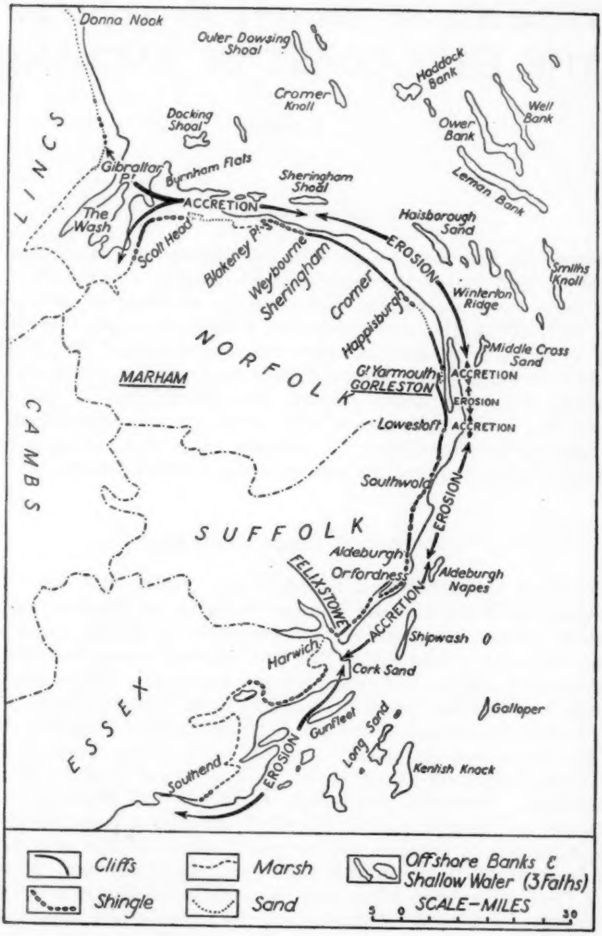

Figure 1
From the Humber to the Thames. Coastal types and the incidence of erosion and accretion (generalised).

The North Norfolk Coast : Some Past and Present Views

The coast between Hunstanton in the west and Weybourne Hope in the east is essentially one where accretion is dominant. The great shingle spit of Blakeney Point (Fig. 1) and the large "barrier beach" of Scolt Head Island, together with the Wells and Stiffkey salt marshes, are only the largest of a whole series of similar depositional features. All are fronted by a vast area of accumulation in the offshore zone much of which is exposed at low tide. The salt marshes, the dunes and the spits and bars are piled up in front of what appears to be an abandoned sea cliff on their inner edge. Straw[1] ascribed this

'cliff' to marine erosion in the last interglacial and the depositional features fronting it to post glacial times. Reid[2] earlier advanced a hypothesis which is no longer seriously considered. He suggested that the chalk slope behind the coastal marshes is not such an abandoned sea cliff but a valley bluff of an "ancient east and west river." In Reid's view the opposite flank has been destroyed by marine erosion while the former valley floor forms the base on which accumulation has taken place. The present-day coastal deposits were interpreted as resorted fluvial material. If this were so, no problem of origin would exist and arguments about the dominance of one direction or another in longshore drift would be futile for, in Reid's words, "here there is little or no lateral movement, and the beach may remain until it is worn out."

In 1927 Steers[3] rejected Reid's hypothesis and formulated an idea which has run through his writings on this subject to the present time. "The general drift down the east coast of England has been responsible for the vast accumulations of sand which underlie the marshes [of north Norfolk] and extend many miles out to sea. The sorting action of the waves has to a considerable extent separated the shingle from the sand and the shingle is now built up into long spits and bars." In 1948[4] he argued that "The Norfolk coast between the Wash and Sheringham acts as a great groyne so that material from Lincolnshire and further north, to say nothing of that raised from the shallow floor of the sea, becomes banked up against the coast." Later he[5] suggested an offshore source specifically for shingle as follows: "Are we justified in assuming that the great quantity of shingle which builds Blakeney Point originated in the Sheringham-Weybourne cliffs and 'Eyes' of glacial material, some of which still exist near Salthouse, or must we assume, as seems essential for the much lesser amounts of shingle at Scolt Head Island, an offshore source?"

Many of our ideas on coastal problems have been governed by Redman's[6] generalisation on the movements of beach material which has been accepted by many later workers: "On the south coast the leeward progression of the shingle is up channel, due to the preponderance of south-west winds; along the eastern seaboard the motion is southward, owing to the greater influence of northerly winds, except along the north coast of Norfolk, towards the estuary of the Wash where the motion is in a westerly direction." The major features of the north Norfolk coast such as Blakeney Point and Scolt Head have grown westwards and lend support to the suggestion that the dominant direction of drift on the coast is to the west. However, the resumption of a southerly drift on the east Norfolk coast from Cromer southwards, which Redman[7] suggested, means that somewhere west of Cromer a "drift parting" exists. Wheeler[8] attributed this supposed parting to a "counter tide close inshore which sets westerly" while Steers[9], who also accepted the idea, thought that dominant waves from the north-east were responsible. If the "drift parting" be accepted, one consequence is that only the short section of cliffed coast between Weybourne and Sheringham is available to supply beach materials for the coast to the west. This is clearly inadequate and the need to look elsewhere, to the Lincolnshire and Yorkshire coasts, and to the offshore zone, becomes obvious. To summarise current views on the north Norfolk depositional features, it is reasonable to stress the following cardinal points. The dominant direction of drift is westwards though Steers has pointed

out that some easterly movement takes place. The Sheringham-Weybourne cliffs can supply only a relatively small amount of the material involved and the bulk must come from the Lincolnshire and Yorkshire coasts and perhaps the sea bed.

Supply of Beach Material

Two factors are most involved; source of supply and direction of longshore drift. These will be examined in turn. If, for the sake of argument, the existence of the "drift parting" between Weybourne and Sheringham be accepted, the only major source of supply of beach material is the eroding coast further north. To equate the excess of material on the north Norfolk coast with the heavy losses on the Holderness coast would represent a very neat solution to two difficult problems. Such an answer will not however bear critical examination. Vast quantities of material are indeed eroded from the Holderness coast. Whether one accepts Reid's(10) estimate of the amount of the annual loss between Bridlington and Spurn Head or the more conservative figures put forward by Mathews(11) beach material derived from this source would be more than enough to account for the accumulation on the north Norfolk coast. Yet this rapidly eroding Holderness coast which, according to Mathews, has lost more than 66,000 acres since Roman times, is separated from north Norfolk by the relatively stable Lincolnshire coast, to say nothing of the Humber and the Wash. Any material eroded from the Holderness coast which passes alongshore is likely to be intercepted long before it reaches north Norfolk. According to Reid(12) much of the warp deposited in the Wash and the Humber can have no other source than the Holderness coast, and the shingle of Donna Nook is also said, and Steers(13) agrees, to stem from the accumulation of Spurn Head. The Lincolnshire coast may intercept material carried southwards by longshore drift from Holderness. Ward(14) observed that . . . "it does not suffer from the coast recession common to other regions on the lee side of estuaries." It cannot itself be a major source of material, for Ward also observed that "The Lincoln coast appears to be stationary apart from local erosion and accretion." The Royal Commission on Coast Erosion reported(15) : "The coastline along the southern banks of the Humber and the coast of Lincolnshire generally to the Wash is for the most part subject to accretion. Only a few places have suffered from encroachment . . . *viz.,* isolated spots in the vicinity of Mablethorpe and Sutton, and at Ingoldmells to the north of Skegness." Barnes and King(16) showed that even the ravages of the 1953 storm surge had been almost completely repaired less than three years later.

If material eroded from the Lincolnshire coast, or passed along it from the Holderness area, were a major contribution to the north Norfolk coast, it is reasonable to suppose that a major feature would occur in the area of Gibraltar Point where the trend of the coast changes and the Wash inlet, with its deep entrance channels, intervenes. It is because the building of a large spit occurs at Spurn Head that an excess of beach material travelling south can be assumed. If a similar excess obtained along the Lincolnshire coast, Gibraltar Point might be expected to rival in size features such as Orfordness. Instead only a tiny spit exists which Barnes and King(17) showed passes through a cycle in which growth is followed by decay. The inference is that the

supply of beach material reaching it is relatively limited. It is strong corroborative, if circumstantial evidence, for the observation by Ward[18] that "Harbour works and groynes in Lincolnshire, *where shingle is practically absent,* have arrested but little sand which here apparently does not drift along the coast." This may well be an overstatement of the case, but it contains a germ of truth.

Even if material were available and passed Gibraltar Point it is unlikely that it would reach Norfolk in large quantities. The sand and shingle moved alongshore would tend to accumulate at the head of the Wash for, on its Norfolk flank, south of Hunstanton, the drift of material is to the south[19]. To take the direct path across the mouth of the Wash would introduce even greater difficulties. This journey of upwards of twelve miles would involve the crossing or by-passing of the Lynn Deeps with depths of 10 to 20 fathoms, even excluding "The Well." Bruun and Gerritson[20] demonstrated that sand could by-pass natural inlets either by crossing a submerged offshore bar or by the process they called "tidal flow" by-passing. No submerged offshore bar exists here to facilitate the passage of material and tidal flow by-passing across such a wide and deep inlet could certainly not carry shingle to the Norfolk coast. The vast accumulation of sand in the Burnham Flats and other shoals of the north Norfolk coast (Fig. 1) would suggest that by-passing, even of sand by tidal flow, would be more likely from south to north rather than in the reverse direction. This offshore accumulation in front of the north Norfolk coast is not matched to the same extent on the Lincoln side and this suggests that material drifting from the east and south is held up. While it is natural to look to the offshore zone when longshore drift seems inadequate as a source of supply and while there is some evidence that sand can move in deep water, there is as yet no case where it can be demonstrated that material from deep water reaches the beach. In his submission to the Royal Commission on Coast Erosion[21] Hansford Worth said "I have no evidence that any material from deep water ever gets on to the beach and I have seen more than a thousand dredgings." Recent work, to be referred to later, has not disproved this.

Movements of Beach Material

Even if the concept of a "drift parting" west of Sheringham and a dominant westerly drift are accepted as major factors on this coast, and even if the problem of supply of beach materials is disregarded, difficulties will arise. Under such circumstances an accumulation of beach materials, particularly of shingle could reasonably be expected toward the west in the Hunstanton area. Redman[22] regarded the accumulations of Dungeness to Sandwich Bay as the "shingle end" of his south coast system of longshore drift. Similarly the Orfordness-Landguard Point area was the terminus of the East Coast drift. He claimed to see such a "shingle end" in the Hunstanton to Snettisham area and beyond, but it is not possible to agree with him that what the Royal Commission on Coast Erosion[23] described as "a certain amount of shingle" can be compared with the great shingle spreads of East Anglia and Kent. Clearly the term "dominant drift" must be used with caution. Steers[24] recognised very early that drift in more than one direction takes place, though the significance of easterly as well as westerly movement, shown in his Scolt Head Island experiments with shingle markers is only

becoming apparent in the light of more recent work. Steers([25]) also drew attention to the Brancaster and Ramsey ridges, which are built in the opposite direction to Scolt Head Island, and to Gore Point and the Wells headland growing in a direction opposite to the "dominant" drift. Similarly he observed that sand appeared to move in a direction opposite to that taken by shingle at Blakeney, Burnham, Brancaster and Thornham.

The idea of a "drift parting" west of Sheringham appears to have arisen because of the juxtaposition of two seemingly conclusive local phenomena. To the west of Weybourne Hope begins the Blakeney shingle spit, the very form of which is strong presumptive evidence for a dominant drift of shingle to the west. At Sheringham itself occur a number of groynes, some of them concrete and of considerable size. At the landward ends of these groynes the shingle is piled high on the western side and there is a drop of several feet on the eastern side. Here is apparent evidence of travel to the east and a complete absence of movement in the opposite direction. On the face of it a drift parting must exist between the Sheringham groynes and the Blakeney spit. The present writer has been unable to find any record of drift experiments on a scientific basis which have shown the existence of such a supposed "drift parting." This being so it may be as well to examine the 'evidence' anew.

Williams([26]) has observed that the disposition of shingle at the top of the beach is often an unreliable indicator of the movement of material as a whole because "it is freak material at a freak level." In this context it is important to notice that in the lower sections of the beach, where sand is more common than shingle, piling up on the western side of the Sheringham groynes does not occur. Williams goes on to say that "It has frequently been observed that the deposition of shingle at the top level of groynes has suggested coastwise movement in a direction exactly opposite to the one prevailing." Steers([27]) observed that groynes at Kessingland and Slaughden "testified to a reversal of beach drift." Though groynes are often the only indicators of the drift of beach material it must always be remembered that they are also often restricted to the top of the beach where shingle tends to be concentrated. The smaller fractions of material can move at lower levels of the beach in the opposite direction, (Steers([28])) possibly under the influence of tidal currents. Groynes also create local conditions which are not representative of the beach as a whole. The breaking wave is directed along a path it would not normally follow and the more oblique the approach of the wave the more scour can be expected. Any conclusions based solely on the evidence of groynes must be treated with very great reserve. Even ignoring the peculiar local effects induced by their very presence, all the Sheringham groynes can show is an excess of *shingle at the top of the beach* towards the east. The evidence from the Blakeney shingle spit is less open to question since no artificial conditions exist but again it must be remembered that this is a feature built at the top of the beach and mainly of shingle. In addition, wind blown, as opposed to wave borne, sand may well have played a not inconsiderable part in its evolution, since the shingle is in places a relatively thin "skin" and sand dunes are superimposed on the shingle at the western end.

Recent Work on the Movements of Beach Material and its Implications

(a) The Sea Bed

The development of new techniques of marking beach materials and improved methods and equipment for both direct and indirect observation of the sea bed have in recent years led to a great increase of information on the movements of material under water, information which was not available when many ideas on beach processes that are still accepted were formulated.

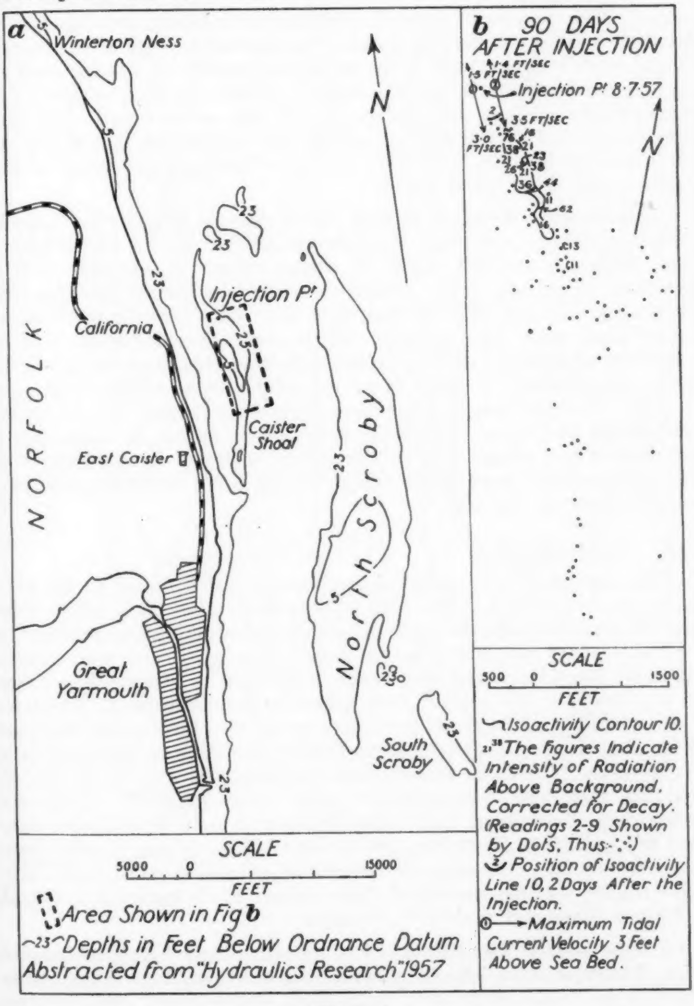

Figure 2
Movement of sand marked with radio-active tracers. Net movement is parallel to the shore in the direction of the resultant of the tidal stream.

Recent experiments and observations have shown that movement on the sea bed tends to be parallel to the shore. No movement from offshore banks or the sea bed to the beach has yet been demonstrated. Stride([29]) has shown that movement of material on the sea bed tends to be parallel to the direction of the tidal stream and thus to the coast. The alignment of sandbanks off the East Anglian coast (Fig. 1) is strong supporting evidence for this, and Reid's([30]) experiment on the Caistor shoal (Fig. 2), using sand marked radioactively, produced similar results. Efforts to replenish beaches with sand fill dumped immediately offshore have failed repeatedly. As an example, such an attempt at Long Branch, New Jersey([31]) showed movement alongshore, but none of the dumped material reached the beach. The inference from all this experimental work is that even if large waves are capable of moving sand and silt at great depth, such material tends to stream in the direction of the resultant of tidal flow rather than to fetch up on the beach. The large deposits of sand off the north Norfolk coast which dry out at low tide, are thus more likely to contribute to beach building as a result of wind blowing than from wave action.

Experiments designed to find out if shingle beaches are supplied from the offshore zone have been almost conclusive. At Orfordness in 1957, Kidson, Carr and Smith([32]) demonstrated a complete lack of movement of shingle in the offshore zone and in further work in 1959, Kidson and Carr([33]) showed that, even over long periods, movement in the offshore zone was confined within very narrow limits and the possibility of material reaching the beach from this area was negligible. Earlier experiments at Scolt Head Island([34]) using similar techniques of radioactive marking showed some limited movement, but no pebbles reached the shore even though the injection point was in water only 12 feet deep at low water. The conclusion to be drawn is that little of the sand and probably none of the shingle of the north Norfolk coast comes directly from the sea bed.

(*b*) Alongshore.

The transport of material alongshore is not confined to the beach above the low water mark. Longshore drift also takes place below water in a narrow belt, the width of which varies with beach gradient. It is usually wider on sand than on shingle beaches. Such movement is intimately bound up with the beach and must be distinguished from any movement on the sea bed from which it is quite distinct. The travel of material alongshore tends to be greatest at, or a little above, the water surface but there is usually a second maximum close to the break point of the waves. Thus in experiments at Anapa on the Black Sea, the Russians including Arboulatov([35]) and Zenkovitch([36]), using sand marked with fluorescent dyes, have shown that very much larger quantities of sand move alongshore below water than do so on the beach above the surface. Similar movement of shingle marked with radioactive tracers was demonstrated close inshore at Orfordness in Suffolk by Kidson, Carr and Smith([37]).

It has already been noted that movement of beach material as deduced from observations of groynes can be misleading. Many generalisations on beach drift stem from such observations and not from controlled experiments. A remarkable feature of recent experimental work has been the revelation of the widespread existence of drift in more

than one direction. Steers'(38) early experiments at Scolt Head Island showed movement to the west with winds from a north-east quarter and movement in the opposite direction when the wind came from the north-west. Hardy(39) showed that at Cley, Weybourne and Sheringham, shingle can move either east or west and he found that the direc-

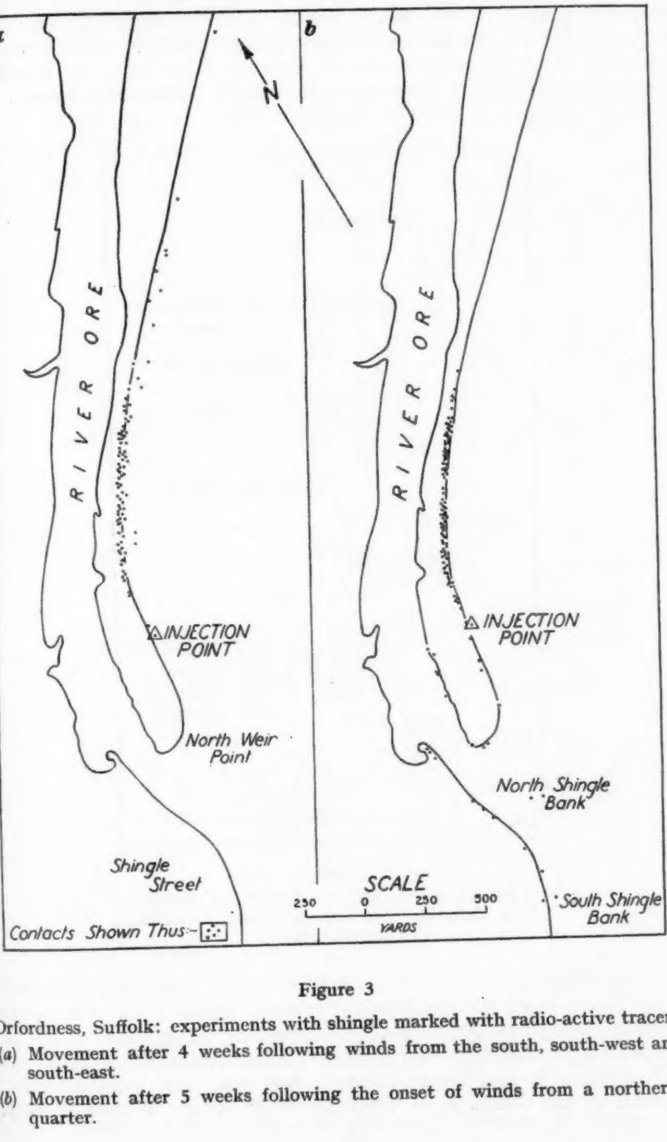

Figure 3

Orfordness, Suffolk: experiments with shingle marked with radio-active tracers.

(*a*) Movement after 4 weeks following winds from the south, south-west and south-east.

(*b*) Movement after 5 weeks following the onset of winds from a northerly quarter.

tion of movement of stones was closely related to wind direction. Steers concluded that the dominant direction of drift was to the west, Hardy to the east. Work on the east coast of East Anglia has shown that drift towards the north is long continued though the opposite direction is commonly held to be dominant. The experiments at Orfordness(40) (Fig. 3) indicated that such northward progression of shingle lasted as long as winds blew from a southerly, south-easterly or south-westerly quarter. Only when winds with a northerly component returned did southward drift resume. Williams(41) has shown the apparent northerly progression of Benacre Ness (Fig. 4) despite an alleged dominant drift from north to south. Drift experiments here could be expected to yield interesting results.

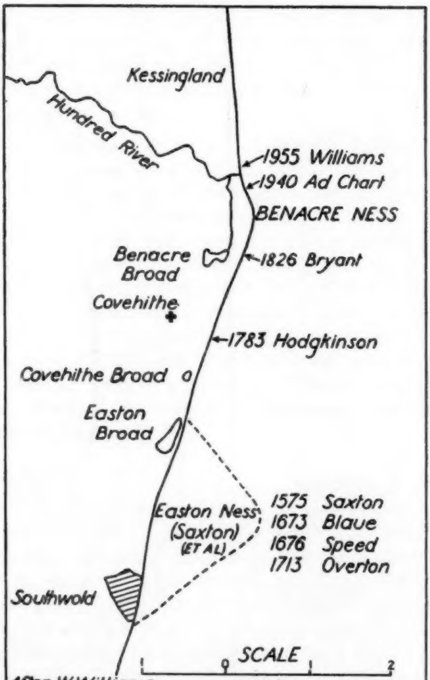

Figure 4

Apparent northward movement of Benacre Ness between the sixteenth and twentieth centuries.

The existence of "counter drift" has thus been demonstrated at several places along this coast and it is now suggested that the evidence is strong enough to revise the "drift parting hypothesis." No such divergent trend has been demonstrated experimentally. A much more likely solution is that material moves first one way then another in response to the direction of wave approach which in turn is in part

determined by the direction of winds both local and distant. Such a balancing of so called dominant drift by "counter drift" introduces the possibility that some part of the north Norfolk coastal deposits derives not so much from the Holderness coasts but from the much closer adjacent shores to the east and south of Sheringham. Here too is an area of serious and long continued erosion. Ward([24]) wrote "The North East coast of Norfolk, has, however, suffered losses probably nowhere exceeded along the English coastline" and she gave an estimate of a retreat of two to three miles since Roman times.

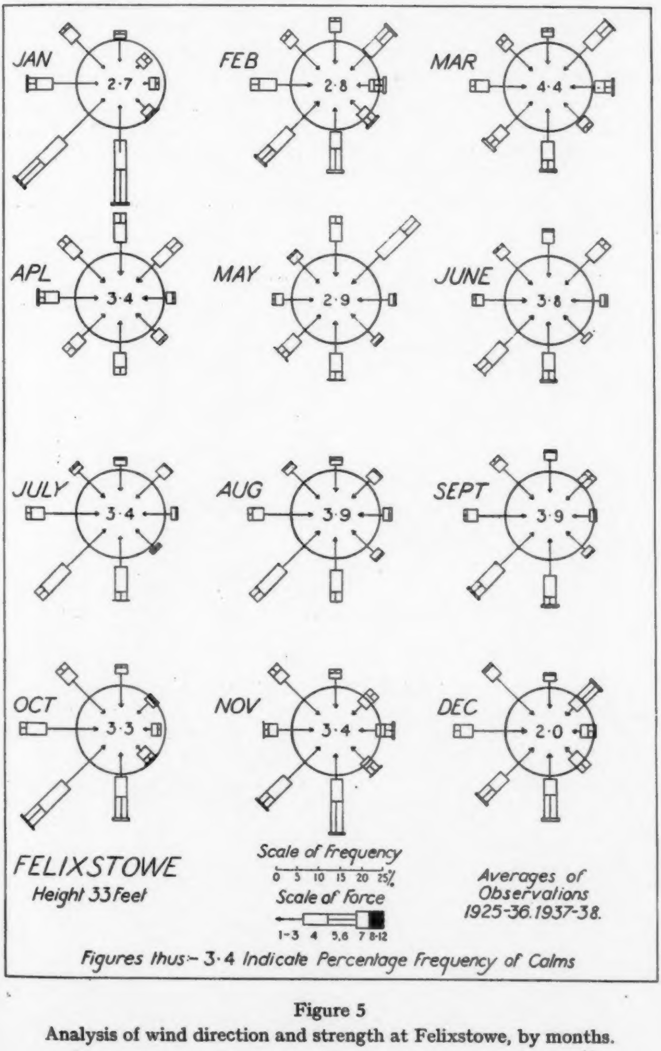

Figure 5
Analysis of wind direction and strength at Felixstowe, by months.

In view of the evidence on "counter drift" it would be more than surprising if some of the products of this erosion did not find their way to the north Norfolk coast. The shingle spreads of Orfordness and the sand spit at Yarmouth are only parts of the product of this vast change. Longshore drift is, as we have seen, oscillatory in character; a backward and forward motion. While the existence of the Sheringham groynes makes it difficult to test experimentally movements of beach material in the completely natural condition under which this coast evolved, the results from the adjacent areas are strongly suggestive. Analysis of available wind records shows that in the light of the experimental evidence a good deal of material from the east Norfolk coast could make its way "round the corner" to Blakeney and beyond. Some of this material may be shingle and the evidence of the Sheringham groynes does not rule this out; much is probably sand.

Figure 5 gives an analysis of wind records over a long period in terms of both strength and direction at Felixstowe, and Tables I and II give an analysis of wind direction over a 5-year period at Marham (the station closest to the north Norfolk coast), and at Gorleston, near Great Yarmouth. The positions of the three stations are indicated in Figure 1.

TABLE I

MARHAM, NORFOLK

Number of days in each month (as an average for the period 1953-57) when the wind blew from a given direction (taken from the Monthly Weather Summary issued by the Meteorological Office.) Offshore winds are in bold type.

	N.	N.E.	E.	S.E.	**S.**	**S.W.**	W.	**N.W.**
Jan. ..	3.4	2.6	2.6	1.9	**5.1**	**7.0**	5.2	**2.2**
Feb. ..	3.6	4.6	2.9	2.1	**3.9**	**4.4**	3.2	**2.5**
Mar. ..	3.0	3.8	4.6	5.0	**4.4**	**3.8**	3.3	**2.1**
April ..	6.4	5.4	3.1	1.7	**2.7**	**4.1**	3.6	**2.1**
May ..	6.4	3.0	2.8	2.1	**4.5**	**4.7**	4.3	**2.8**
June ..	7.0	3.1	2.4	2.0	**3.0**	**5.1**	4.1	**2.9**
July ..	4.6	3.5	1.2	1.4	**3.2**	**6.5**	7.2	**2.9**
Aug. ..	4.0	2.5	2.4	1.6	**4.1**	**5.8**	6.6	**2.8**
Sept. ..	1.5	1.1	2.3	2.1	**5.1**	**7.3**	7.5	**1.9**
Oct. ..	4.5	1.0	0.2	2.2	**6.7**	**7.3**	4.6	**3.3**
Nov. ..	5.1	2.2	1.6	2.4	**6.6**	**3.9**	3.7	**2.6**
Dec. ..	1.5	1.4	2.1	3.3	**6.6**	**8.1**	5.8	**2.5**
Year ..	46	34	28	28	**56**	**68**	59	**31**

TABLE II

GORLESTON, NORFOLK

Number of days in each month (as an average for the period 1953-57) when the wind blew from a given direction (taken from the Monthly Weather Summary issued by the Meteorological Office.) Offshore winds are in bold type.

	N.	N.E.	E.	S.E.	S.	**S.W.**	**W.**	**N.W.**
Jan. ..	2.0	3.1	3.3	0.9	4.3	**5.9**	**8.8**	**2.7**
Feb. ..	3.0	2.3	3.3	1.2	4.6	**3.7**	**5.7**	**3.5**
Mar. ..	2.9	4.0	4.5	3.1	5.8	**2.8**	**5.1**	**2.8**
April ..	6.7	6.3	3.0	1.2	3.5	**3.0**	**4.2**	**2.5**
May ..	5.8	3.8	3.0	1.6	6.1	**3.5**	**4.4**	**2.8**
June ..	6.3	3.7	2.8	1.6	4.9	**4.2**	**3.5**	**3.8**
July ..	2.1	2.4	1.0	1.0	5.5	**4.6**	**7.5**	**2.7**
Aug. ..	2.9	3.1	1.9	2.2	4.0	**4.5**	**8.8**	**3.8**
Sept. ..	1.2	1.7	2.1	2.9	4.7	**5.6**	**9.4**	**2.9**
Oct. ..	2.1	0.8	0.4	0.8	4.4	**6.8**	**8.9**	**4.4**
Nov. ..	3.0	1.5	1.6	1.7	6.3	**5.0**	**7.3**	**3.8**
Dec. ..	1.0	1.5	1.6	2.1	5.4	**7.0**	**9.8**	**2.6**
Year ..	39	34	28	20	59	**56**	**83**	**38**

These three records show that, over the whole East Anglian coast winds from virtually all directions can blow for long periods and through their influence on the direction of wave approach can thus move material in all directions. Under such wind conditions, taking account of the effects of swell generated far outside the region, beach drifting might be more persistent in one direction than another, but movement in the opposite direction must take place at some time. It would be surprising indeed if some material from the east Norfolk coast did not find its way beyond Sheringham. Much of it would return whence it came, but the possibility that some would stay "trapped" on the north coast is very real. Only winds persistently blowing from the west and north-west would carry it beyond the confines of this coast. Wind records can be, at best, only suggestive in this context, but taken in conjunction with the experimental evidence from East Anglian sites, they demonstrate the need for a new look at old theories.

Conclusions

Generalisations about the direction and amount of beach drifting have in the past led to assumptions which are unjustified by the facts. The material of the north Norfolk coast is unlikely to be derived from the Lincolnshire and Yorkshire coasts. Little is contributed directly from the offshore zone, though wind blown sand from the intertidal area may be important. Much of the material may be fossil in the sense that it is glacial material resorted by marine action and distributed under different conditions from those now prevailing. Some contribution from the erosion of the eastern shores of East Anglia is also probable. The existence of a "drift parting" has never been satisfactorily demonstrated. Further experimental work is necessary, particularly in the Weybourne Hope to Cromer area, and especially at the lower levels of the beach.

Acknowledgements

Figure 2 is adapted from "Hydraulics Research" 1957, and is published with the kind permission of the Director, Hydraulics Research Station, Wallingford. I am grateful to Mr. W. W. Williams for permission to reproduce Figure 4. Figure 5 is based on the "British Climatological Atlas," and Tables I and II were constructed from the Monthly Weather Summary published by the Meteorological Office. This material is reproduced with the sanction of the Controller of H.M. Stationery Office.

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THE DERBYSHIRE IRON INDUSTRY SINCE 1780

K. WARREN

Slag heaps intermingled with mine tips, now often being quarried for in-filling material or flattened for building development, the decaying remnants of former iron works and the dark outlines of those surviving—all these contribute to the landscape of the coalfield of eastern Derbyshire. The iron firms, now often no more than names in old trade directories, or memories of their former work-people, sank many of the coalmines still in production on the exposed section of the coalfield as well as on the concealed portion, mainly in Nottinghamshire, lying to the east of the Magnesian Limestone outcrop. While the local iron ore pits are now indicated only by minor hollows or hummocks often covered by trees it should not be overlooked that the needs of the Derbyshire iron furnaces also led the local ironmasters to play a pioneer role in the opening up, a century ago, of the still active Jurassic ore-fields of the East Midlands. Directly and indirectly, therefore, the Derbyshire iron industry has had an important influence on landscape and economic life, both locally and regionally.

IRON-MAKING RESOURCES OF EAST DERBYSHIRE AND THE EARLY IRON INDUSTRY

Within the broad outcrop of the Middle Coal Measure rocks of this section of the Yorkshire, Derbyshire and Nottinghamshire coalfield are resources of both fuel and ore, although from an ironmaster's point of view the quality of coal declines south of the Don. The Better Bed coal, whose purity was so important in the manufacture of "Best Yorkshire" iron, is not found south of Barnsley. The Silkstone Seam, which supplied coke to the crucible steel makers of Sheffield, thins and loses its coking quality south of Chesterfield. Historically the most important seam to the Derbyshire ironworks was the Barnsley Bed, which, though non-coking in type, is similar to the "splint" coals of Scotland and was, like them, used raw in the furnace(1). When other seams were used in ironmaking they were often mixed with Barnsley Bed or Silkstone coal(2).

Iron ore, of clayband type, occurs as layers—locally known as "rakes"—or as nodules in the coal measures, and has an iron content of about 30%. Ore working was always by primitive means, including the digging over of surface outcrops or the sinking of bellpits, *i.e.*, shafts ten yards or so in depth from the base of which ore was worked in all directions. Bellpits are found above the outcrop of the Silkstone Seam and where local folding and subsequent erosion exposed concentrations of the rakes so that ore yields per acre were especially high. Examples of such folding are the so-called Ironville anticline, opened up by the River Erewash, the Riddings dome, south of Alfreton, and the Brimington anticline, north-east of Chesterfield. Their importance was great, for, as furnaces were built where ore could most easily be obtained, the minor folds became localising factors in the industrialisation of the area. Figure I shows the relationship of coal and iron ore resources to blast-furnace locations.

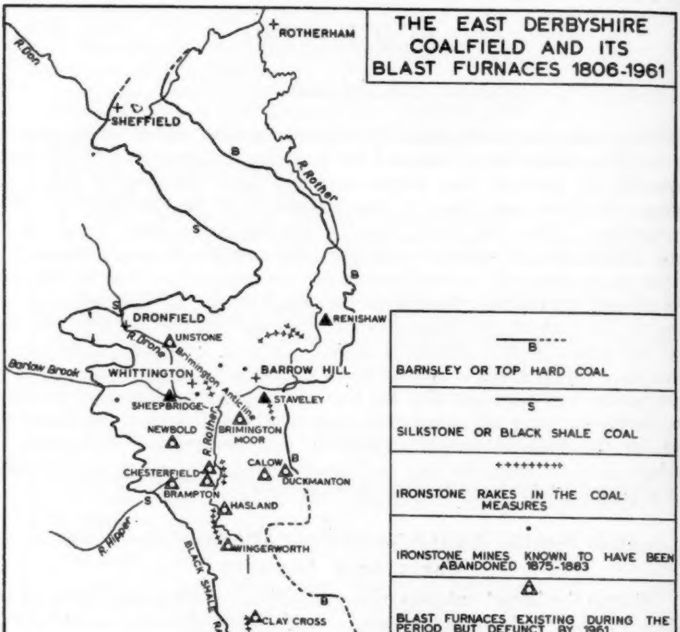

Figure 1
Only the more important ironstone rakes are shown. Their location has been derived from Geological Survey one inch to one mile maps and from accounts of ironstone mining. The outcrops of the various seams have also been taken from the Geological Survey maps, but that part of the outcrop of the Barnsley Bed shown by a pecked line has been interpolated from other sources.

Medieval ore working and subsequent smelting in bloomery hearths —little more than blacksmith's forges—were practised in a number of places in Derbyshire. These were chiefly on the coalfield of East Derbyshire. Production was necessarily on a small scale and units could be installed, abandoned or moved with but small capital loss. Charcoal fuel was used in the bloomery, but the presence of Coal Measure ore and the possibility of using coal in the forging process which followed smelting gave the coalfield considerable locational attraction. The high grade, though small, hematite deposits of the Carboniferous Limestone may also have been used(3).

After the blast furnace superseded the bloomery, some of the modern centres of the industry emerged, but rapid advance awaited the introduction of coke smelting to the county in 1780. At the same time as this important technical advance was made transport was improved by canal cutting and the laying of tramways from collieries and furnaces(4).

New works were projected, furnace plants extended, and more ore shafts put down, while the demand for coal for local industry and for regional domestic consumption required the extension of coal mining. The creaking cranes at the bellpits and the hammer of stone-laying at the furnaces along the reeking River Rother mocked Defoe's century-old description of Chesterfield—". . . . here is little or no manufacture"(5). But compared with other coal and iron districts, Derbyshire's industrialisation at this time was small. In 1830 Britain made 677,000 tons of pig iron; of this Derbyshire made no more than 18,000 tons. Great expansion in the second quarter of the century was to be caused by the introduction of rail transport and the application of the hot blast to iron smelting(6).

Railways, Technical Change, and the Iron Trade

In some iron districts, and above all in South Wales, the building of the railways provided the trade with a major new market for iron, so that the whole structure of the industry altered as works turned to the production of railway material. In Derbyshire the effect was mainly in the form of better access to markets in the rest of the country. Those ironmasters who possessed very extensive coal properties were for the first time able to sell house coal to the metropolitan and other markets, while those who carried iron manufacture all the way to the finished product also benefited; but, most important, it became possible to produce pig iron to be shipped elsewhere for puddling and finishing. Rail transport removed from the Derbyshire smelting industry the restrictions of a very limited local market for iron.

The introduction of the hot blast made possible the increase in production which rail transport made profitable. The practical application of Neilson's hot blast in Scotland at the end of the 1820's proved not only that furnace-make could be increased and fuel consumption lowered, but that the terribly wasteful process of open-heap coking could be avoided. In Derbyshire, penalised in the past by its poor coking coal, it was soon found that Barnsley Bed coal made an excellent furnace fuel when charged raw into the hot-blast furnace(7). Stimulated on both the production and marketing side the trade expanded in spectacular fashion. Between 1830 and 1851 two works went out of production but six new

ones were established([8]) and the number of furnaces increased from eleven to twenty-nine. By 1869 forty-three furnaces made 188,000 tons pig iron, ten times the output of 1830.

Much of the iron poured from Derbyshire furnaces was finished in other metal districts. With nearby Sheffield the connection was slight, although in 1856 Thomas Firth set up puddling furnaces at Whittington, near Chesterfield, and, presumably using local pig iron, began both to cast and roll iron([9]). A few years later John Browns were using Sheepbridge iron in puddling and iron plate manufacture at the Atlas Works in Sheffield([10]). The introduction of steel manufacture severed the link between Derbyshire and the works of the Don Valley, however, for local iron was not of steelmaking quality.

The finished-iron works and foundries of Lancashire were never adequately supported by local furnaces, and Derbyshire might have seemed well located to make good this deficiency, but in fact the main Derbyshire market was in the Black Country of South Staffordshire. Here, as ore supplies dwindled and the Thick Coal proved both harder to get and less and less satisfactory as a furnace fuel, outside supplies of pig iron became a necessity for the continuance of the wrought iron trade. In 1866, when its own pig production was 533,000 tons, South Staffordshire and Worcestershire also brought in about 300,000 tons of pig iron from other districts([11]). Much of this came from Derbyshire. One quarter of a century later two thirds of the pig iron used in South Staffordshire forges came from other districts([12]).

Some Derbyshire works finished off their own iron and Butterley, the greatest of these, seems to have been partially dependent on pig iron from its neighbours([13]). Butterley was, however, in all respects exceptional, and in the early 1860's twelve of the fifteen furnace plants were selling pig iron out of the county([14]). Local production of puddled iron was on a small scale, and observers looked hopefully for the day when the industry would expand. But the county suffered little when, in the late 1870's and 1880's, steel ousted iron from one market after another and caused the loss of millions of pounds in dismantled puddling furnaces and iron rolling mills([15]). Derbyshire continued to supply iron to the surviving forges of Staffordshire and at the same time was increasing its specialisation on cast iron goods, especially pipes. Table I shows the national decline in the output of puddled bar and the small extent to which Derbyshire engaged in the production of this type of iron.

TABLE 1

PIG IRON AND PUDDLED BAR PRODUCTION ('000 tons)

	United Kingdom		*Derbyshire*	
	Pig Iron	*Puddled Bar*	*Pig Iron*	*Puddled Bar*
1877 ..	6,608	1,724	328	25
1882 ..	8,493	2,841	445*	40
1894 ..	7,364	1,339	210	25
1905 ..	9,608	938	568	24

*Includes Nottinghamshire

Sources: British Iron Trade Association Statistical Reports

Steel manufacture on a large scale was never adopted by Derbyshire works. When Firths built open hearth furnaces in 1884 they were installed not at Whittington but at the Norfolk works in Sheffield. In the 1870's Wilson-Cammell operated a major rail mill and Bessemer

converter plant at Dronfield, but in 1883 the whole plant was moved to Workington (Cumberland). The Butterley Company, however, built an open hearth melting shop at Codnor Park at the end of the 1870's to supply its mills and, in order to provide the necessary hematite pig iron, Spanish ore was imported and hematite occasionally worked in the Dove valley, on the Staffordshire border. Steel making appears to have proved difficult, and the melting shop was finally closed in 1902([16]). No major steel plant has since been built in the county.

The Iron Trade and the Landscape

In the middle forty years of the nineteenth century the landscape of the coalfield was largely transformed. Coal and ore pits multiplied, new works were built, and old ones added to, while waste heaps, cuttings and viaducts one by one obscured the natural contours of the land and confused its drainage. New industrial villages arose amidst farmland and country villages became industrial towns. Figure 2 shows the distribution of iron works and collieries in 1861.

To the north Whittington and Dronfield exemplify the process very well. In the 1850's coal was being worked from three shafts at Sheepbridge, near Whittington, and in 1857 the foundation stones of three furnaces were laid([17]). A year earlier Firth's Whittington works had been established. Soon Whittington Moor, which a few years before had been a waste, bore a fair-sized settlement, and the parish population increased more than threefold in the 1850's (874 to 2,864), and doubled again in the 1860's (to 5,578 in 1871). Eventually this large industrial parish became part of the borough of Chesterfield.

The Dronfield district for long supplied Sheffield with coal by cart([18]) and plans for development of its mineral resources by Sheffield capital only awaited the completion of the projected railway from Chesterfield to Sheffield([19]). The Midland Railway Company laid this line in 1870 and rapid growth of industry followed, with the population rising from 3,253 in 1871 to 5,169 in 1881. In 1872 the Wilson-Cammell rail mill and steelworks came into production, and the township of 719 houses in 1871 contained 1,170 houses ten years later. As early as 1875 it was said to have "shops equal to the largest towns"([20]). Within eight years the works had been removed and Dronfield became a critically depressed area where recently built houses were sold for extraordinarily low sums, and the fine shops were one by one abandoned as tradesmen lost their livelihood([21]). Elsewhere urban growth was often less spectacular but more securely based. Company villages like Codnor Park and Ironville in the Erewash valley or Barrow Hill within a mile of the Staveley works embodied in a dull uniformity of pattern the prevailing paternalistic relationship between master and men, and contrasted sharply with the haphazard lay-out of older settlements([22]).

Changes in Raw Material Supplies

Although the Derbyshire iron trade avoided the financial loss, company failure and unemployment which in other metal districts marked the coming of steel, it had somewhat earlier begun a scarcely less important adjustment, the replacement of raw material self-sufficiency by dependence on outside supplies. The change was rapid in the case of ore supplies, slow in the case of fuel.

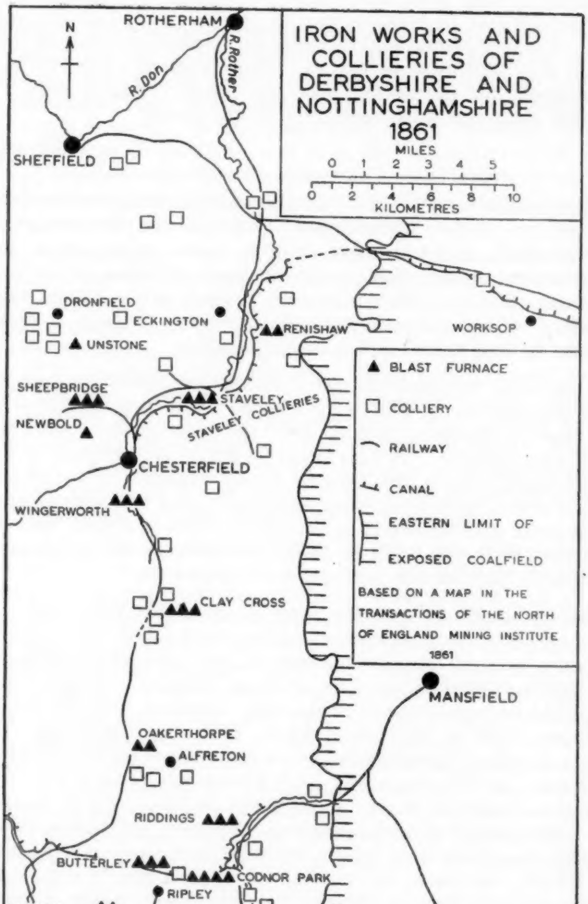
IRON WORKS AND
COLLIERIES OF
DERBYSHIRE AND
NOTTINGHAMSHIRE
1861
MILES
0 1 2 3 4 5
0 2 4 6 8 10
KILOMETRES
N
ROTHERHAM
R. Rother
R. Don
SHEFFIELD
DRONFIELD
ECKINGTON
UNSTONE
RENISHAW
WORKSOP
SHEEPBRIDGE
STAVELEY
STAVELEY COLLIERIES
NEWBOLD
CHESTERFIELD
WINGERWORTH
CLAY CROSS
MANSFIELD
OAKERTHORPE
ALFRETON
RIDDINGS
BUTTERLEY
CODNOR PARK
RIPLEY
MORLEY PARK
BELPER
DENBY
R. Derwent
WEST HALLAM
ILKESTON
NOTTINGHAM
R. Trent
TO DERBY
R. Erewash
STANTON
BLAST FURNACE
COLLIERY
RAILWAY
CANAL
EASTERN LIMIT OF
EXPOSED COALFIELD
BASED ON A MAP IN THE
TRANSACTIONS OF THE NORTH
OF ENGLAND MINING INSTITUTE
1861

Figure 2

In the 1860's Jurassic ore began to supplement that drawn from the local bellpits; by the 1870's it was steadily replacing it. Northampton Sands ore was first worked in 1852, but in 1859, when the Frodingham field of Lincolnshire was opened up, iron ore production in the whole Jurassic belt south of the Humber was only 176,000 tons, compared with 325,000 tons raised in Derbyshire. The new ore had to prove its quality, and then, when railway access had been provided, much of it in the early years was supplied to Staffordshire and South Wales([23]). Coal measure ore production in Derbyshire ranged between 350,000 and 400,000 tons a year from 1855 to 1870, and in the iron trade boom which accompanied the Franco-Prussian war reached almost 500,000 tons. But in the following years local ore pits were one by one abandoned, and each year Jurassic ore took a larger share of the furnace charge of Derbyshire ironworks([24]). By the end of the 1870's the make of "all mine" pig—that is iron made from local ore—was almost confined to two of the fourteen works of the county, Butterley and West Hallam([25]). In the eight years following the Franco-Prussian war Derbyshire iron production increased by 26 per cent., but local ore supply fell from 42 per cent. of the total in 1872 to 16 per cent. in 1880([26]) (Table 2).

TABLE 2

IRON ORE USED IN DERBYSHIRE FURNACES, 1872-1880

Source of ore	*1872*	*1876*	*1880*
Derbyshire ..	317,560	220,000	165,000
Northamptonshire	290,500	494,402	696,903
Lincolnshire ..	1,500	6,508	11,826
Other districts ..	136,000	53,914	153,928
TOTAL ..	745,560	774,824	1,027,657

Source: Meade, op. cit., p.477.

Northamptonshire ore, which was cheaply conveyed to Derbyshire by the lines of the Midland Railway, was in iron content litle different from local ore, but working conditions were very much easier. Outcrop working was general at this time and there was only a shallow cover to remove. Variability of chemical composition and the existence of partings of waste material were sometimes troublesome—though to a greater extent in the Frodingham ore beds than in the Northampton Sands—but the beds were, on the other hand, thick and continuous and could be worked by powder, pick, shovel and wheelbarrow in open pits. In all respects Derbyshire ore was less easily won. The thickness of the rakes varied greatly even over short distances and, as a result, local yields sometimes varied sharply from year to year([27]). The seams were separated by a great deal of dead ground, so that even the Black Shale rakes, the most productive in the coalfield, contained on average no more than 3 feet 6 inches of ironstone in about 30 feet of dirt([28]). The yield of each bellpit was necessarily small and their costs were increased by dependence on primitive lifting devices([29]). Although Coal Measure ore produced an iron superior to that made from Jurassic stone, this was insufficient gain to counterbalance the latter's cost advantage([30]) (Table 3).

TABLE 3

PRODUCTION AND COST OF DERBYSHIRE AND JURASSIC ORE, 1891

	Output (tons)	*Iron content (Per cent)*	*Av. cost per ton at mine or open working* s. d.
Derbyshire ..	20,810	30	7 6
Lincolnshire* .. (openworks)	1,138,092	33	2 6
Northamptonshire (openworks)	1,043,541	36	2 3

* In 1891 Lincolnshire produced an additional 76,039 tons ore from workings which came under the Coal Mines Regulation Act.

Source: Mineral Statistics of the United Kingdom, 1891.

As the Derbyshire iron companies abandoned their local pits they acquired Jurassic ore properties. Staveley early obtained holdings in the Frodingham (Scunthorpe) district of North Lincolnshire, and further south the Wingerworth Iron Company began working near Stamford in the 1870's. In Northamptonshire Stanton opened quarries at Finedon, Wellingborough and Desborough, and Staveley developed the Cranford deposits. By 1883 Sheepbridge was obtaining ore daily from Rutland, while completing its preparations for working in Northamptonshire and negotiating for ore lands in Lincolnshire([31]).

Between 1871 and 1880, as local ore supplies dwindled, there was a net increase of eleven in the number of furnaces in Derbyshire and Nottinghamshire. Near Ilkeston two new plants, the Erewash Valley and Awsworth (or Bennerley) works were built, and in 1881, across the county boundary in the Leen valley north of Nottingham, the Bestwood furnaces came into blast. These, which were the last new works built in the district, looked from the first to the new orefields for their supplies. Pig iron production in the Jurassic belt grew only slowly, the Derbyshire-Nottinghamshire ironworks, together with certain other coalfield works, consuming almost half the ore from these fields as late as 1890. Table 4 shows the size of the ore deficit in Derbyshire and Nottinghamshire, and of the ore surplus in the Jurassic belt in this year. Figure 3 shows trends in ore and pig iron production in Derbyshire and Northamptonshire between 1855 and 1880. The ownership of coal mines and Jurassic iron ore workings by Derbyshire iron companies is illustrated in Figure 4 (situation in 1924).

TABLE 4

PIG IRON PRODUCTION, ORE CONSUMPTION AND LOCAL ORE SUPPLY

1890 (tons)

	Derbys.	*Notts.*	*Northants.*	*Lincs & Leics.*	*Oxford, Rutland & Wilts.*
Pig iron production	387,760	75,900	225,046	268,405	c 20,000
Ore and 'cinder' consumption	1,117,258	225,640	616,852	914,915	c 60,000
Iron ore production	23,732	614	1,278,381	1,662,373	143,339

Source: Mineral Statistics of the United Kingdom, 1890

Changes in fuel supply were much less rapid than the substitution of Jurassic for Coal Measure ore. Although in the second quarter of the century the expansion of the iron trade had been associated with the success of uncoked coal as a furnace fuel, coke seems never to have been completely displaced. The Clay Cross furnaces were built in 1846 in part, at any rate, to serve as an outlet for coke surplus to the needs of the North Midland Railway(32). By the early 1880's South Yorkshire ovens were supplying Derbyshire ironworks with considerable amounts of coke(33), but at some works with furnaces designed to use raw coal coke proved an unsatisfactory substitute(34).

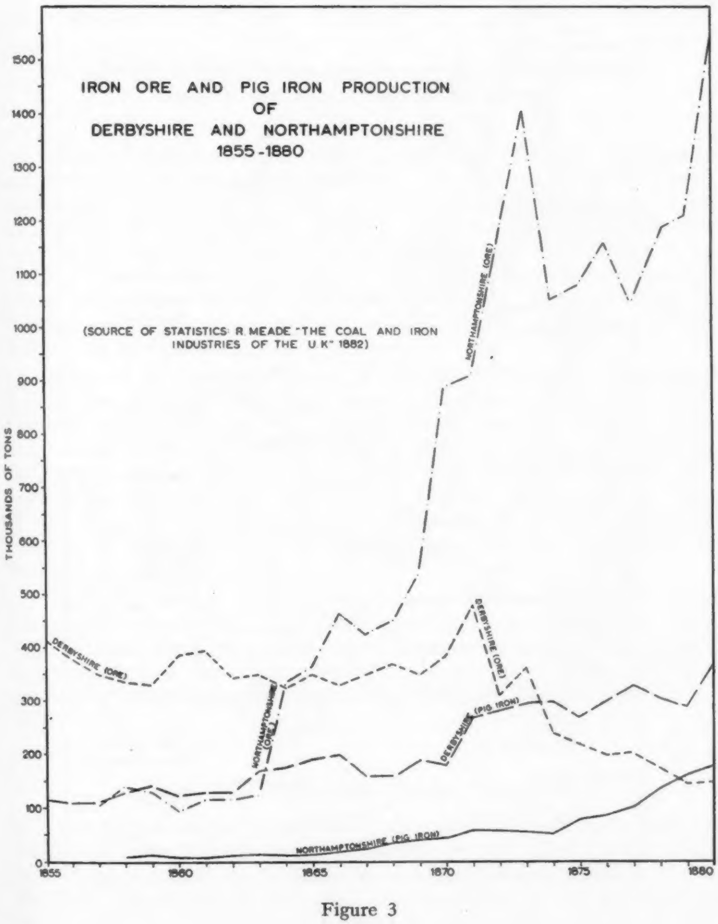

Figure 3

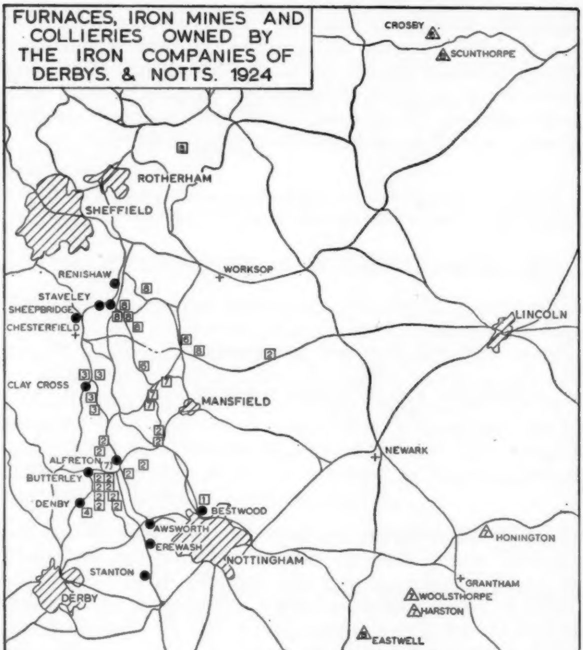
FURNACES, IRON MINES AND COLLIERIES OWNED BY THE IRON COMPANIES OF DERBYS. & NOTTS. 1924
CROSBY
SCUNTHORPE
ROTHERHAM
SHEFFIELD
RENISHAW
STAVELEY
SHEEPBRIDGE
CHESTERFIELD
WORKSOP
LINCOLN
CLAY CROSS
MANSFIELD
NEWARK
ALFRETON
BUTTERLEY
DENBY
BESTWOOD
AWSWORTH
EREWASH
NOTTINGHAM
STANTON
DERBY
HONINGTON
GRANTHAM
WOOLSTHORPE
HARSTON
EASTWELL
WALTHAM
WARTNABY
HOLWELL
BUCKMINSTER
ASFORDBY (7)
MELTON MOWBRAY
COTTESMORE
TILTON
LEICESTER
PILTON
DESBOROUGH
ROTHWELL
GEDDINGTON
LODDINGTON
CRANFORD
BURTON LATIMER
BRIXWORTH
N
BLAST FURNACE PLANTS
COAL MINES
IRON ORE MINES
NUMBER INDICATES OWNER
1. BESTWOOD
2. BUTTERLEY
3. CLAY CROSS
4. DENBY
5. E. P. DAVIS (AWSWORTH & EREWASH BLAST FURNACES)
6. SHEEPBRIDGE
7. STANTON
8. STAVELEY
9. LODDINGTON IRONSTONE COMPANY:- THE FOLLOWING HAD INTERESTS IN THIS COMPANY:-
SHEEPBRIDGE
STAVELEY
BESTWOOD
NEW CRANSLEY
JOHN BROWN & CO.
RAILWAYS
MILES
0 5 10
0 10 20
KILOMETRES
(SOURCE: RYLANDS DIRECTORY OF THE COAL, IRON AND ALLIED TRADES 1924)

Figure 4

By this time it had become clear that the use of raw coal burdened the Derbyshire works with low productivity (see Table 5) and consequently high costs per ton. The cost of coking, it is true, was avoided, but as furnaces were built higher in order to increase their output it was found that coal would neither support such a heavy burden of material in the furnace as metallurgical coke nor permit the use of high blast temperatures. By 1893, Derbyshire, still very largely using raw coal, ranked thirteenth of fifteen ironmaking districts of the country in average furnace output.

TABLE 5

AVERAGE ANNUAL MAKE PER BLAST FURNACE AT WORK (tons)

	1873	*1893*	*1906*	*1920*
United Kingdom	9,512	22,032	27,598	28,243
Derbyshire	7,601	10,518	14,158	20,009*

*Includes also Nottinghamshire, Leicestershire and Northamptonshire

Source: Meade, B.I.T.A. and B.I.S.F. statistics.

Many of the small works seem to have used only raw coal throughout their lives, but the bigger companies were by the end of the century consuming coke as well as coal—probably fed to the furnaces as a mixture. In the 1880's and 1890's Staveley used both raw coal and coke from beehive ovens at its collieries to the south-east of the works([35]) and Stanton operated coke ovens at its Teversal and Silverhill collieries some fifteen miles north of the works([36]). However, even by 1906 the Stanton works was using only 200 tons of coke a week compared with 5,000 tons of hard coal([37]).

Early in the twentieth century more radical changes in fuel supply began when in 1904-1905 Clay Cross replaced its beehive ovens with a by-product plant([38]). In 1907 Staveley built what was in effect a major new works to the east of the existing plant, consisting of by-product coke ovens, extensive chemical plant and large new blast furnaces to be exclusively fed with coke fuel. This plant revolutionised the Derbyshire iron trade, so that within a few months of its opening pig iron, made at 42 shillings a ton, was undercutting Stanton's production cost by eight shillings a ton([39]).

But even with such unequivocal proof of the superiority of coke the use of raw coal was only slowly given up. As late as 1915 Derbyshire furnaces were using about equal amounts of raw coal and coke([40]), and Stanton had only colliery-located beehive ovens in the 1920's and did not commission its first by-product coke plant at the ironworks until 1940.

The Failure of the Small Ironworks

The capital cost of ovens and of the large new furnaces which were desirable to take full advantage of the use of coke placed coke smelting beyond the reach of the smaller plants. At the same time the markets for their iron began to disappear as contraction in the wrought iron trade went on. The high-phosphorus iron which they made from Northamptonshire ore could find no alternative outlet in steelmaking,

for basic Bessemer steel had fallen into disfavour and their antiquated blast furnaces could not be efficiently converted to the production of the large quantities of cheap basic or hematite pig which basic and acid open hearth steel furnaces needed.

After the First World War the decline in the wrought iron trade was accelerated, and as puddling mills were closed in the Black Country so furnaces were blown out in Derbyshire. National production of puddled bar, which totalled 1.2 million tons in 1913, fell to 308,000 in 1924 and 54,000 in 1938.

By the end of the 1920's Bestwood, Denby, Awsworth, and the Erewash Valley works, all without finishing capacity, made their last casts and in two and a half years from June, 1928, seventeen of the thirty-five furnaces in the county were demolished or went permanently out of production. The larger companies, too, sent some iron to forges and foundries in other districts, but they also possessed large finishing plants. Butterley and Sheepbridge had important rolling mills, but at other works the main activity was iron-founding, especially the production of cast-iron pipes. While other furnace plants were being dismantled these latter works were busy making the pipes for the sprawling housing estates of the twenties(41). Rationalisation of production occurred, however, within the firms concerned, the Alfreton (Riddings) works, owned by Stanton, closing in 1926, and the old works at Staveley by 1930. In 1926 Butterley, engaged in a wide range of engineering as well as being a major coal producer, abandoned its blast furnace plant(42). There was possibly some neglect of the iron-works themselves in favour of development of major new collieries in the concealed coalfield of Nottinghamshire. In the mid-1920's the Butterley Company, at Ollerton, and Stanton Ironworks, at Bilsthorpe, were engaged in shaft sinking and colliery-village building and related development work(43), while Sheepbridge and Staveley also had major interests in deep pits in the same area(44). Until the nationalisation of the coal industry in 1947 all the iron companies remained also major coal producers. Figue 5 shows the ownership of coal-mines by Derbyshire iron companies in 1938.

The Derbyshire Iron Industry Since 1930

In the last thirty years raw material sources for the Derbyshire ironworks have not changed greatly and the product range has remained broadly the same. Clay Cross, pioneer in the county's by-product coking industry, closed its ovens in the early 1950's, and in the recession of 1958 blew out and later dismantled its furnaces. Its pipe foundries are now supplied with pig iron from Stanton. The latter in the inter-war years acquired rival ironworks and pipe foundries, and then in 1939 Stanton itself became a subsidiary of the firm of Stewarts and Lloyds, which was carrying out a contemporaneous but even more far reaching reorganisation of its steel tube manuufacture, including the development of the new integrated works at Corby, Northamptonshire(45). Staveley, whose new plant had been such a formidable competitor in 1907, was by 1959 operating the county's four smallest furnaces. In 1954 it had, however, purchase the much more modern plant at Sheepbridge. In 1960 Stewarts and Lloyds obtained further control of the Derbyshire iron industry by acquiring the Staveley-Sheepbridge company, and in

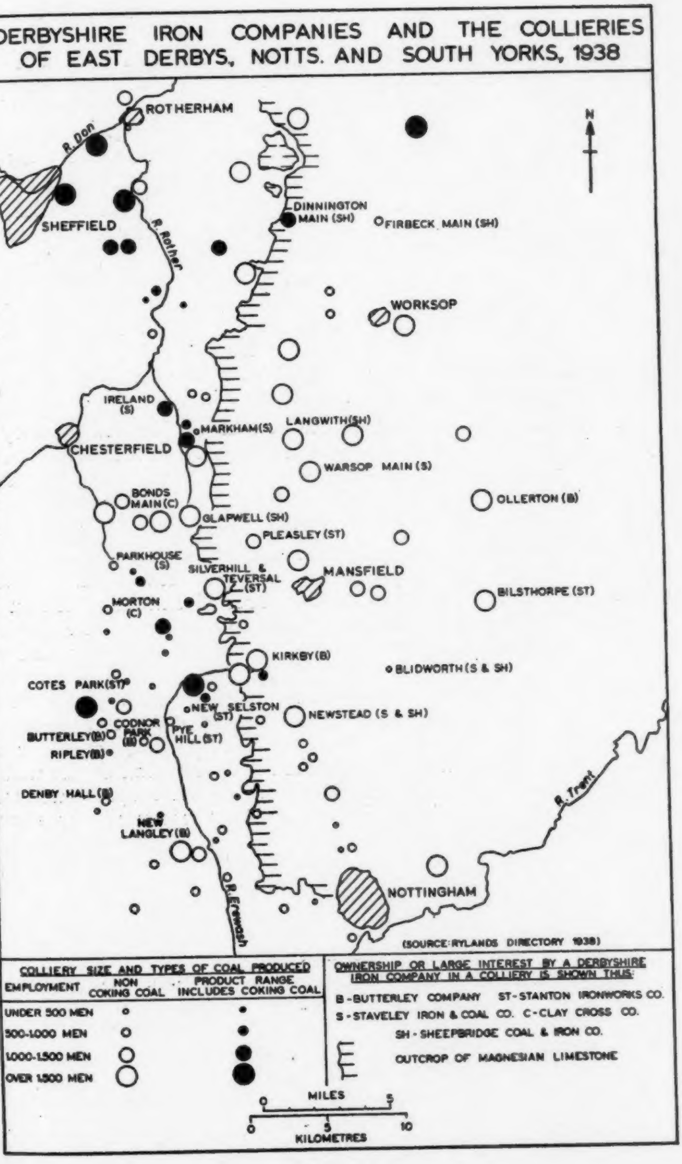
DERBYSHIRE IRON COMPANIES AND THE COLLIERIES OF EAST DERBYS., NOTTS. AND SOUTH YORKS, 1938
N
ROTHERHAM
R. Don
SHEFFIELD
R. Rother
DINNINGTON MAIN (SH)
FIRBECK MAIN (SH)
WORKSOP
IRELAND (S)
MARKHAM (S)
LANGWITH (SH)
CHESTERFIELD
WARSOP MAIN (S)
BONDS MAIN (C)
OLLERTON (B)
GLAPWELL (SH)
PLEASLEY (ST)
PARKHOUSE (S)
SILVERHILL & TEVERSAL (ST)
MANSFIELD
MORTON (C)
BILSTHORPE (ST)
KIRKBY (B)
BLIDWORTH (S & SH)
COTES PARK (ST)
NEW SELSTON (ST)
NEWSTEAD (S & SH)
CODNOR PARK (B)
BUTTERLEY (B)
PYE HILL (ST)
RIPLEY (B)
DENBY HALL (B)
R. Trent
NEW LANGLEY (B)
R. Erewash
NOTTINGHAM
(SOURCE: RYLANDS DIRECTORY 1938)
COLLIERY SIZE AND TYPES OF COAL PRODUCED
EMPLOYMENT
NON COKING COAL
PRODUCT RANGE INCLUDES COKING COAL
UNDER 500 MEN
500-1,000 MEN
1,000-1,500 MEN
OVER 1,500 MEN
OWNERSHIP OR LARGE INTEREST BY A DERBYSHIRE IRON COMPANY IN A COLLIERY IS SHOWN THUS:
B - BUTTERLEY COMPANY
ST - STANTON IRONWORKS CO.
S - STAVELEY IRON & COAL CO.
C - CLAY CROSS CO.
SH - SHEEPBRIDGE COAL & IRON CO.
OUTCROP OF MAGNESIAN LIMESTONE
MILES
0
5
0
5
10
KILOMETRES

Figure 5

the summer of 1961 a merger of Stanton and Staveley (within the Stewarts and Lloyds organisation) was announced. In the autumn of 1961 the closure of the Sheepbridge furnaces took place—a vivid illustration of the disadvantages of the producer of iron for sale, even with thoroughly up to date plant(46). In 1954 Renishaw had become part of the widely spreading Steel Division of Tube Investments Ltd., and began to produce steelmaking iron to be used in the Division's melting shop at the Round Oak works at Brierley Hill, Staffordshire. The Renishaw blast furnaces will also supply part of the pig iron needs of the additional steel-making capacity now under construction at the Park Gate works at Rotherham.

Iron ore now comes almost entirely from the Jurassic fields, each company operating quarries which are either directly owned or controlled through associated companies(47). Renishaw depends on outside supplies of coke (as did Sheepbridge), but it is within a few miles of National Coal Board ovens. Staveley and Stanton both have their own coke-oven plants, the former obtaining its coal from local pits. Stanton was still buying half its coke in 1951(48), and although it has since more than doubled its coking capacity(49) it has to bring coal from distant pits to blend with the local coals of poor coking quality(50).

In addition to pipe casting on a large scale at Stanton, Staveley and Clay Cross, the works at Butterley and Sheepbridge roll both iron and steel and are engaged in a range of engineering activities. Forge and foundry iron is still sent on a large scale to consumers throughout the country, though no plant is to-day wholly a producer of merchant iron.

In the 180 years since coke smelting began in the area between the Trent and the Don iron production has been undertaken at twenty-six locations, but now survives at only three (Renishaw, Stanton and Staveley). The ironstone bell pits have for a long time now lain unworked and flooded or overgrown. Years of prosperity led to a peopling of country districts, the building of new settlements or the extension of old ones, and stimulated the development of railways and the expansion of the coal trade. Changed raw material supplies, the almost complete replacement of wrought iron by steel, growth in size of plant, and competition and mergers led to a reduction of the number of iron-making locations. But the effect on the landscape is not easily removed. When works closed down they left a legacy of waste heaps, old mineral ways and derelict plant; while, by contrast, the few works which remain stand out, black and smoking, as major active features of the industrial landscape.

NOTES

(1) In Derbyshire the Silkstone Seam is known as the Black Shale coal and the Barnsley Bed as the Top Hard. R. Meade, *Coal and Iron Industries of the United Kingdom* (1882) p.101 refers to the Top Hard at Staveley as a 'strong splint'.

(2) A. H. Stokes, The Economic Geology of Derbyshire, *Trans. Chesterfield and Derbyshire Inst. Mining, Civil and Mechanical Engineers* (1878) pp.21-24.

(3) For early ore working and ironmaking see *Victoria County History, Derbyshire* Vol. 2 (1907) pp.356-361.

(4) On canals see *V. C. H., Derbyshire* Vol. 2 (1907) p.187. On tramways see B. Baxter, Early Railways in Derbyshire, *Trans. Newcomen Society* Vol. XXVI (1947-49) p.185.

(5) Daniel Defoe, *A Tour Through the Whole Island of Great Britain 1724-1727* (1957) (Ed. G. D. H. Cole) Vol. 2, p.587.

(6) For earlier details see H. Green, The Nottinghamshire and Derbyshire Coalfields before 1850, *Journal of the Derbyshire Archaeological and Natural History Society* Vol. LVI (1935), 44-60.

(7) The saving at Codnor Park was described by A. Ure, *A Dictionary of Arts, Manufacture and Mines* (1843) p.698. In 1829 using coke and cold blast each ton of iron production involved the consumption of 6.82 tons coal (coked), 2.64 tons ore and 0.87 tons limestone and the output per furnace was 29 tons iron a week. In 1835-6 using hot blast and raw coal the same furnaces made 49 tons iron a week and consumed for each ton of output 3 tons coal, 2.72 tons ore and 0.77 tons limestone.

(8) The new plants were at Unstone, Newbold, Brimington, Clay Cross, West Hallam and Stanton.

(9) *100 Years in Steel: A History of Firth-Brown* (Sheffield ,1937) p.46.

(10) *Mines, Mining and Iron Manufacture of the County of Derby*. Reprinted from the *Derbyshire Red Book* (1862) p.6.

(11) J. Jones, Assistant Secretary of the South Staffordshire Ironmasters Association in Samuel Timmins (Ed.), *The Birmingham and Midland Hardware District* (1866) p.68.

(12) *Iron*, 1 April 1892, p.298. By 1905 about 5,000 tons a week of Derbyshire, Northamptonshire and other pig iron was brought into Staffordshire (*Iron and Coal Trades Review*, 6 January 1905, p.33.).

(13) In 1852 Butterley made a bid to purchase the Stanton works and, defeated in the attempt, was a month later negotiating to buy 5,000 tons pig iron from the same works. See A. Gladwin (Chief Clerk to the Stanton Ironworks), *A diary of events in Derbyshire, 1852-1855*, p.61. (This diary is in Chesterfield Public Library).

(14) *Derbyshire Red Book* (1862), pp.6-8.

(15) One estimate put the loss in puddling furnaces abandoned in Britain in the years 1875-1885 at £4.6 million and the loss of employment at 39,000. D.A. Wells *Recent Economic Changes* (New York, 1890) pp.141-142.

(16) R. H. Mottram and C. Coote, *Through Five Generations: The History of the Butterley Company* (1950) pp.94, 162. C. Erickson, *British Industrialists: Steel and Hosiery 1850-1950* (1959) p.161, suggested that the open hearth steel went into rails, but this seems very unlikely for almost all rail steel was then made in the Bessemer converter. Butterley, moreover, had a large outlet for steel in its plate mills and constructional work. Erikson is the only source for the 1902 date for the closure of the melting shop.

(17) *Staveley News* Autumn 1957, p.182.

(18) J. T. Woodhouse, On the Progress of Coal Mining in the Counties of Derby and Nottingham, *Transactions North of England Institute of Mining Engineers* Vol. X (1861) p.123.

(19) *Colliery Guardian* 28 March 1863, p.254.

(20) *Colliery Guardian* 14 May 1875, p.703.

(21) The cause of the move was the burden of freight rates to the ports in competition with coastal plants. See *Iron*, 24 March 1882, p.232 ; 31 March 1882, p.250; 14 April 1882, p.289 ; 4 January 1884, p.12. When, 48 years later, the Penistone works were closed *The Times* suggested that at Dronfield houses had been sold for as little as £5 each. *The Times*, 21 February 1930, p.11.

(22) In the 1880's the whole of the village of Codnor Park, with church, schools, reading rooms and library, swimming baths and gas and water works was owned by and under the direct control of the Butterley Company (*Transactions North Staffordshire Inst. of Mining and Mech. Engineers* Vol. 9 Part 3 (1887) p.88). Mottram and Coote, op. cit., p.48, attribute the name Golden Valley, given to the area between the two Butterley owned works of Codnor Park and Butterley, to the beneficent effect which the company's operations had on the district. The Staveley Company, in addition to similar activities, arranged with the University of Cambridge for the provision of local lectures. (*Colliery Guardian* 1 January 1875, p.16).

(23) In 1853 1,000 tons Northamptonshire ore a week was being sent to Wales and it was also being asked for in Staffordshire (*Mining Journal* Vol. 23, 1853, p.555). In 1857 the county produced 107,985 tons ore. Its own pig iron output was 11,500, representing a consumption of about 30,000 tons ore. Of the 70,000 tons sold outside the county 20,000 tons were sent to Derbyshire (*Mineral Statistics of the United Kingdom*, 1857).

(24) Between 1875 and 1883 Derbyshire companies abandoned ore mining on at at least eighteen properties in the county (*Reports of the Inspectors of Mines, 1883, List of Mines Abandoned, Derbyshire*, pp.78-81).

(25) C. S. BRAGGE, The Coal and Iron Industries of Derbyshire and Nottinghamshire, *Trans. The Surveyors Institute* Vol. LIV Part XII (1911-1912) p.569.

(26) I. L. BELL, in evidence to the Royal Commission on the Depression of Trade and Industry 1886, gave slightly different figures by considering the local contribution in relation to total furnace charge—that is including "cinder" as well as ore. His figures for percentages of iron made from local ore are 1860, 89 ; 1865, 55 ; 1870, 64 ; 1875, 24 ; 1880, 12 ; 1884, 1.6.

(27) MEADE, op. cit. p.469, noted that in 1873 the Staveley district produced 173,664 tons ore, in 1874 only 19,511 tons.

(28) J. T. WOODHOUSE, op. cit., p.119.

(29) At Birdholme, south of Chesterfield, one large central engine had provided the winding power for 38 ore pits (*Derbyshire Times* 20 December 1935).

(30) Because of its improving quality Coal Measure ore remained profitable to work in some areas where it could be won along with coal. (*Trans. Fed. Inst. Mining Engineers* Vol. 2 (1890-91) p.25).

(31) *Colliery Guardian* 31 August 1883.

(32) *A Hundred Years of Enterprise.* Published for the Centenary of the Clay Cross Company (1937) pp.14, 25 ; and *Trans. Instit. Mining Engineers* Vol. XXXIII Part 4 (1907) pp.386-397.

(33) *Iron*, 5 January 1883.

(34) This was the situation at Staveley, where attempts to use coke for long proved unprofitable (*I.C.T.R.* 2 May 1884, p. 541). As late as 1889, in a survey of resources for expansion, Staveley shareholders were informed that the company had a supply of hard coal 'eminently fitted' for the heating of the furnaces and the coal workings were being extended (Report of the Annual Meeting of the Staveley Coal and Iron Company Ltd., 1889, *Derbyshire Times* 28 September 1889).

(35) *Staveley News* Vol. 4 No. 1, p.22.

(36) *Trans. Fed. Inst. Mining Engineers* Vol. 2 (1890-1891), pp.544, 550.

(37) *Account Book and Diary of Events at Stanton 1906-1911* kept by J. A. LONGDEN, Manager of the Stanton Ironworks Company (Derby Reference Library).

(38) *Trans. Fed. Inst. Mining Engineers* Vol. XXXIII (1907) pp.387-8.

(39) The figures are those given in Longden's diary for October 1907. Staveley was selling at only 2/- a ton less than Stanton, so netting 6/- more per ton of pig made at the new works. Early in 1908 it was reported that a syndicate of Sheffield and other steelmakers were planning to lay down steelworks near to the new Staveley works. The project came to nothing. (*I.C.T.R.* 31 January 1908, p.446).

(40) R. A. MOTT, *The History of Coke Making* (1936), p.46.

(41) As early as 1894 Staveley has been capable of 70,000 tons of pipe castings a year. (*I.C.T.R.* 22 June 1894, p.782). By 1905 Sheepbridge, with pig capacity of 60,000-70,000 tons a year, had its own pipe foundries and forge and also rolling mills capable of handling 24,000 tons of iron and steel a year (*Journal of the Iron and Steel Institute* 1905 No. 2, p.46). Casting operations at Stanton were by 1915 capable of taking 120,000 of its annual pig output of 160,000 tons (*Rylands Directory*, 1915).

(42) In 1923 one of the Butterley directors noted that it had been suggested that the company should join the movement to the coast so as to avoid the great burden of rail charges, but the idea had been rejected 'knowing the distress that would ensue in the district if the works were closed' (*Colliery Guardian*, 19 January 1923, p.166).

(43) *Colliery Engineering* October 1937, pp.331-2 and November 1931, p.418 et seq. surveys the Ollerton and Bilsthorpe projects respectively.

(44) LORD ABERCONWAY, *The Basic Industries of Great Britain* (1927), p.42 commented: "Whilst most of the collieries belonging to these companies and all the more recently sunk pits in the district are thoroughly well equipped and worked upon the most approved modern systems, it cannot be said that all the Derbyshire ironworks have adopted the newest appliances". However at the end of the 1920's Stanton undertook a wholesale replacement of old blast furnace plant (*I.C.T.R.* 15 June 1928, p.924).

(45) In 1919 Stanton had purchased the furnaces and pipe foundries at Holwell, Leicestershire, and in 1932 the Wellingborough Ironworks, a rival producer of forge and founding iron. In 1933 Cochranes of Middlesbrough, another pipemaker, was acquired. For an account of developments at Corby see D. C. D. POCOCK, Iron and Steel at Corby, *The East Midland Geographer*, No. 15 (June, 1961), 3-10.

(46) The first new furnace at Sheepbridge was blown in in 1951 and the second in 1952 (*I.C.T.R.* 11 September 1953, p.581). The closure is attributed to a growth of iron-making capacity at steelworks, thus dispensing with the need for iron from the merchant plants (*I.C.T.R.* 13 October 1961, p.813).

(47) The Renishaw ore properties were not obtained until 1956.

(48) *The Stantonian*, December, 1951.

(49) *Gas World Year Book*, 1955 and 1958.

(50) At the beginning of 1959 50-55 per cent of the coal coked at Stanton was from Derbyshire or Nottinghamshire mines, 30-35 per cent from South Yorkshire and the rest from Durham or South Wales (Information from the Company).

SOURCES OF CAPITAL IN THE INDUSTRIAL DEVELOPMENT OF NOTTINGHAM

J. M. Hunter.

The accumulation of surplus funds and their transfer, whether on a local or wider scale, to productive uses elsewhere, are indisputably of great importance in the initiation and perpetuation of industrial activity in any given area. No list of industrial location factors fails to include the necessary availability of capital, but what is not generally examined is the origin of this capital and the manner in which it becomes available to the manufacturer. Similarly, if the concept of "industrial momentum" is a valid one then a continuing supply of capital, as the following observations in the case of Nottingham attempt to demonstrate, must be recognised as a principal force assisting such momentum.

Private and Joint-Stock Banks.

Apart from personal savings and private loans, banks were the main source of capital for industrial enterprise in the period prior to the general introduction of limited liability in 1855. No fewer than eight independent banks were established in Nottingham: one in the 17th century, one in the 18th, and six in the 19th, the earlier ones being private and the later joint-stock. The services they offered were indispensabie to industrial progress. However, our immediate aim here is not to examine these services but to determine, where possible, the various sources of capital that the banks drew upon at the time of their formation.

Let us consider the private banks first. They include, so far as the writer can ascertain, Messrs. Samuel Smith and Co., I. and I. C. Wright and Co., Hart Fellows and Co., Moore and Robinson, and Rawson, Inkesole and Rawson. Since they were private banks no records were published, and information is accordingly difficult to come by, but fortunately, a certain amount of information is available.

Smith's.

Smith's, founded in 1688, was the first recorded provincial bank in England, bills being discounted at that time for merchants from as far afield as Leeds, Sheffield and Manchester(1). Thomas Smith was a successful dealer in textile fabrics with whom customers deposited spare money. The banking activities grew until they were eventually separated from textile trading in 1699. So considerable was business that Smith's set up its own London bank in 1758 rather than use the services of an agent as the other Country banks were doing.

Smith's Bank served the Nottingham merchants well, but by the middle of the 18th century newly arising industry was crying out for capital. With the advance of the Industrial Revolution, Nottingham had become an "investing" area as opposed to a "savings" area. Rural districts with few outlets for investment could provide capital provided suitable banking facilities were arranged. Consequently Smith's helped to marry Nottingham's industrial needs to dormant agrarian

surpluses by opening an associated bank at Lincoln in 1775. As a measure of its success we may observe that by 1799 its total assets amounted to £322,000 and its note issues ran as high as 70 per cent. In Nottingham, more liable to sudden demands from manufacturers, the proportion was only 36 per cent.(2). During this period Smith's, under the active leadership of the founder's grandson, Abel II, established associated banks at London in 1758 in partnership with John Payne, at Lincoln in 1775 with Richard Ellison and John Brown, and at Hull in 1784 with William Wilberforce, the famous reformer. A bank was also opened at Derby in 1806(3). With these regional foci established, the net was thus spread wide to harvest a surplus of capital from the London discount market in the south and from the coffers of the landowners of Lincolnshire and the merchants of Hull in the north. At the centre of this net, with its booming domestic hosiery industry, was Nottingham, and Smith the banker, one of its most distinguished citizens. But apart from setting up this banking organisation to the advantage of the town's industry, Smith also invested personally in the transport developments of the period. His executors listed holdings in eight turnpike trusts and in the Trent Navigation, together valued, in 1800, at £1,385(4).

WRIGHT'S.

In 1760 a second private bank was established in Nottingham, by Ichabod Wright, a merchant who had previously been "extensively engaged in the Baltick Trade, in Timber, Iron, Hemp, etc., also in Lead . . ."(5). The banking business prospered through careful management, and a family tradition of sound conservatism was established which successfully weathered many financial storms. In addition the bank's connections were strengthened by marriage(6). Unfortunately, however, little is known about the bank's financial transactions(7). It is known that shares were taken in the Cromford Canal and that Arkwright, the cotton spinner, received some help in his early days from Wright; but when this help was withdrawn Arkwright turned to Need and Strutt, the hosiers. That Wright should have withdrawn his support should occasion little surprise since he was a banker, cautious by nature, and not an entrepreneur. However, one member of the family did venture with success beyond the strict confines of banking into the cut and thrust of industry. In 1830 W. J. Wright withdrew from the bank on terms which were "highly advantageous"(8) to him and established an ironworks in Derbyshire under the name of the Butterley Company. When the later was registered for limited liability in 1888 the Wright family owned 92 per cent of the nominal capital of £600,000(9).

HART, FELLOWS & CO.

At the close of the 18th century Nottingham was served by Smith's and Wright's but, with the continuing and rapid expansion of framework knitting, these were to prove insufficient and by 1808 the hosiers themselves had added three new banks. One was a partnership, established in 1808, between Francis Hart, John Fellows and Charles Mellor. Hart was a former hosier and Fellows a silk merchant. As in the case of the Wrights business ties were strengthened through marriage, in 1804 Hart's daughter marrying into the Lloyds, the great Quaker banking family(10). Significantly Lloyds were the London

agents of the company and were eventually to absorb them during the amalgamation movement which began at the end of the century.

Rawson, Inkersole & Rawson.

The small private bank of Rawson, Inkersole and Rawson was set up by hosiers and lace manufacturers in 1808([11]). It disappeared within a few years, presumably swept away by a sudden run of the type so well described by Wright in his diary. Of the 1825 panic he wrote: ". . . Above 120 Banks suspended payment, some to open their doors no more . . . I suffered great anxiety and alarm but through the aid of merciful Providence we were carried safely through the danger . . . In Nottingham all who were concerned in the Lace Trade suffered great losses and depreciation of property. Amongst the lower orders there was great distress."([12]).

Moore & Robinson.

Rather more is known of the bank of Moore and Robinson, founded in 1802 as Moore, Maltby, Evans and Middlemore. Its earliest partners were formerly associated with lace and cotton manufacturing, building and the law. When, in 1836, it was reconstituted as a joint stock bank of unlimited liability, with 152 signatories, its principal partners were Heard and Mills, hosiers, and Henry Leaver, a lace manufacturer([13]). It was undoubtedly a manufacturers' bank. Its first published accounts, produced on the adoption of limited liability in 1866, show, on analysis, that 19 per cent. of the shares were taken up by lace manufacturers and 4 per cent. by hosiers. Nottingham shareholders held 91 per cent. of the shares([14]).

Companies registered for limited liability are compelled by law to submit returns to the Registrar of Public Companies. These show, at least in the 19th century, the address, occupation and share-holding of each subscriber, and it is therefore a simple, although rather tedious, operation to analyse the distribution of holdings at any given time according to place of residence and occupation.

Nottingham & Nottinghamshire.

Continuing industrial growth in the 19th century, coupled with the advent of joint stock banking, led to the formation of three further banks, each sponsored by hosiers and lace manufacturers. They were the Nottingham and Nottinghamshire, the Nottinghamshire Joint Stock, and the Nottingham and District.

The Nottingham and Nottinghamshire was constituted in 1834 as a joint stock bank with unlimited liability. There were 424 subscribers but unfortunately their occupations are not indicated on the Deed of Settlement. William Melville, hosier, cotton merchant and lace manufacturer, was the first sponsor. A prospectus was issued, in the customarily glowing terms, declaring, with some truth, that Nottingham was ripe for joint stock banking: "The district of Nottingham appears peculiarly favourable for the establishment and success of a Joint Stock Bank. The manufactory is thriving and extensive; there is a great body of wholesale dealers and merchants; an opulent and resident Gentry; a very numerous and wealthy tenantry; a large and well-employed population; and a most respectable class of retail dealers"([15]). An analysis of

holdings in 1874 shows that the textile trades had subscribed 22 per cent. of the paid-up capital. Lace manufacturers held 13 per cent. of the shares, hosiery manufacturers 1 per cent., and cotton doublers, silk throwsters, dyers and bleachers 8 per cent.([16]).

NOTTINGHAM JOINT STOCK.

In contrast to the banks established earlier, the Nottingham Joint Stock was formed under limited liability from the start. Its sponsor was Thomas Adams, a leading lace manufacturer, who enlisted the support of other prominent manufacturers, notably Stephen Wills, lace manufacturer; Thomas Riste, lace merchant; Abraham Tolley, silk throwster; and Thomas Bayley, leather manufacturer. "It has long occasioned surprise," ran the prospectus, "that no additional Banking accommodation has been provided to develop the resources of this important seat of the manufacturing industry"([17]). The venture was a success, with shares at a premium when the doors opened for business on September 1st, 1865.

However, this bank did not wholly conform to the normal pattern of promotion by local manufacturers. What is curious and interesting about its formation is that the Nottingham promoters entered into an agreement with Joseph Whittaker, an agent of the Birmingham Financial Company. Thus, when one examines the distribution of holdings in 1866, six months after registration, one finds that no less than 76 per cent. of the shareholders, owning 51 per cent. of the shares, belonged to residents of Birmingham and the Black Country. They included gunsmiths, manufacturing jewellers, button makers, grocers and ironmasters.

It would seem, therefore, that Birmingham was at this time searching for investment outlets. Nottingham persons formed only 18 per cent. of the shareholders, although, admittedly, they held 43 per cent. of the shares. Nottingham textile manufacturers took up 25 per cent. of the shares, Adams himself accounting for 8 per cent. Lace manufacturers held 18 per cent. of the shares and other textile interests 7 per cent. With the steady expansion of the bank the proportion of Birmingham shareholders diminished and was less than 20 per cent. in 1882([18]).

NOTTINGHAM AND DISTRICT.

The Nottingham and District([19]), the last bank to be founded in Nottingham, was promoted under limited liability in 1889 by Thomas Hill, a hosiery manufacturer. Hill began manufacturing in 1883 at a time when the hosiery industry was undergoing rapid development, and within six years he had promoted the bank with the support of other local textile manufacturers, who subscribed 25 per cent. of the capital. Hosiery manufacturers formed the largest group of shareholders (hosiery 11 per cent., lace 6 per cent., and ancillary textile interests 9 per cent.). Of the shareholders 77 per cent. lived in Nottingham, 7 per cent. in Birmingham, and 3 per cent. in Leicester([20]).

But even as the last bank was being established in Nottingham the days of small, independent, provincial banks were already numbered. By a series of amalgamations, commencing in 1891 and finally terminating in 1924, all the local banks were absorbed by the Big Five([21]). With these changes there was, inevitably, a disappearance of local identity.

The main conclusions to emerge so far in this brief survey are that these banks were established to keep pace with quickening industrial development and that they, in fact, initiated much of that development. They arose to meet local needs, and were locally sponsored to a large extent. Through a flow of capital into and out of the local banks Nottingham was particularly well served for continuous industrial expansion.

Successful Company Promotions

Yet, active as the local bank promoters were, their efforts alone could not have sustained Nottingham in its industrial expansion. By the mid-19th century it had become imperative to extend limited liability to ordinary manufacturing and trading enterprises in order to facilitate a safe and easy subscription of capital by large and small investors alike. By the Limited Liability Act of 1855([22]) general limited liability was introduced. Thus businesses could now be safely financed by numerous passive investors and a fuller exploitation of economic changes became possible.

Three major industries in Nottingham to-day are the manufacture of tobacco, cycles and pharmaceutical products. The sources of capital for the leading firms at the time of the adoption of limited liability are examined in the remarks which follow. Company history and details of location factors cannot be discussed here.

Player's.

The tobacco business founded by William Wright in 1823 was taken over by John Player in 1877. In 1895 limited liability was adopted, and in 1901 the company became a founder member of the Imperial Tobacco Company. An analysis of holdings in 1895 reveals a largely private business, all the Ordinary shares being taken by the family. Three-quarters of the Preference shares were taken by Nottingham investors, but strangely enough only one was a lace manufacturer. The list of subscribers who took up the rather expensive £50 shares, was characterised by professional people : solicitors, architects, accountants, "widows" and "gentlemen"([23]).

Humber

Thomas Humber started manufacturing cycles in Nottingham in 1868. He later formed a private company, which was reconstituted under limited liability in 1886, following which three new factories were opened in Wolverhampton and Coventry. The latter place, to which Humber and Co. eventually removed entirely, was described at this time as "the principal seat of the English cycle business"([24]). As a result of the conversion to limited liability, Humber himself held only 4 per cent. of the capital. His main backers were the Lamberts, lace bleachers, dyers and finishers, with 10 per cent. of the shares, and the Harts, a Wolverhampton engineering family, with 8 per cent. Only 5 per cent. of the subscribers came from Nottingham, although they accounted for 25 per cent. of the shares([25]). While not lacking in local support, the bulk of Humber's capital was raised in the City of London. This feature illustrates the growing tendency towards a decline in the regional character of capital subscription combined with an increasing centralisation on London.

RALEIGH

When the Raleigh Cycle Co. was registered in 1889 half the subscribed capital of £8,000([26]) stood in the name of Frank Bowden, and half was equally divided between his two partners. Bowden had retired from Hong Kong, where he had accumulated his capital. His partners, Woodhead and Angois, were both local machinists. A fresh registration in 1899 increased the capital to £31,000([27]). In contrast to Player's £50 share, Raleigh issued a 2/6 share aimed at the smaller investor. As in the case of Humber's promotion, only a minority of the shareholders, 28 per cent., came from Nottingham. These most belonged to the lace trade and included lace manufacturers, merchants, dyers, bleachers, dressers, machine holders, pattern designers, thread manufacturers and yarn merchants. In the 1899 registration Bowden's share of the holdings dropped to 30 per cent., the next largest investor being G. H. Ellis, of Leicester, with 12 per cent. Ellis was the representative of a Nottingham tannery, Turney Bros., which sold leather to the Leicester shoe manufacturers. Earlier, in 1892, Sir John Turney, of the Trent Bridge Leather Works, had taken up 500 x £1 shares in the Raleigh Co.([28]).

BOOT'S.

Jesse Boot, who commenced a pharmaceutical business on his own in 1877, adopted limited liability in 1883 with £4,698 paid-up capital, all subscribed by himself([29]). Early backers included Cutler, a Nottingham hosiery manufacturer, who subscribed £1,000 in 1889([30]), Mitchell, a Birmingham pen-maker, and Humphries, a Kidderminster carpet-maker, who subscribed £1,500 and £1,000 respectively in 1899. In that year Boot owned 68 per cent. of the £47,200 paid-up capital([31]).

In order to develop his schemes, Boot, with an entrepreneurial talent of the highest order, promoted four companies, each succeeding the other, in the first five years of incorporation from 1883 to 1888, and two more before the close of the century. By this time he had developed a company structure and organisation, as well as a means of access to capital, that was to enable him to expand on an enormous scale. He separated the retail and manufacturing sides of the business in 1892 and subsequently formed a number of associated companies to accommodate the growth of his chain of retail stores; and a not insignificant proportion of the capital for these promotions came from the man in the street. Boot was well aware that customers could become share subscribers, however humble and limited their means. He used his retail stores to good effect by displaying prospectuses and subscription forms. For example, in June, 1903, he offered 120,000 x £1 shares, which were immediately taken up all over the country, from Gloucestershire to Yorkshire, by all manner of persons : miners and engine-drivers, dentists and journalists, publicans and pawnbrokers, police-constables and fishmongers. Boot appealed to the investor at large, therefore, and not specifically to the Nottingham area. Indeed, Nottingham was hardly ever significant as a source of capital after 1900. It contributed 45 per cent. of the subscribers in 1888, and only 17 per cent. in 1899; and thereafter the proportion declined further.

Nottingham's three largest firms, Boot's, Raleigh and Player's, show a common trend. Although initially each was locally inspired and backed, largely by capital from the traditional industries, each so

widened its associations that local subscription became no longer important. Dependence on Nottingham capital, so vital in the early stages of growth, declined as each company rose to a position of national prominence.

Unsuccessful Company Promotions

Obviously not all the companies spawned with the help of capital transference were successful. Many were still-born; others swiftly withered away. From Nottingham's graveyard of dead companies, the following examples are selected at random. The first was completely abortive. The Nottingham and Midland Counties Land and Building Company, hopefully registered for a nominal capital of £10,000 in June, 1876, found only 93 of its total number of 5,000 shares taken up. It was killed at birth by a trade recession. In September of the same year the company's solicitor was obliged to write to the Registrar of Public Companies explaining that "trade in the town being so bad, no business whatever has been done." The Company was formally dissolved in 1886(32).

In contrast, the Erewash Valley Iron Company continued for several years. It was registered in 1872 with £12,000 called-up capital, 75 per cent. of which came from Nottingham, including 20 per cent. from James Oldknow, a lace manufacturer. But it never fulfilled the hopes of its promoters, and approaching insolvency caused its final dissolution in 1885(33). Compared with its large neighbour, the Stanton Ironworks, with more than twenty times the subscribed capital, the Erewash company was insignificant.

Inevitably, too, a certain amount of capital was fraudulently diverted. For example, in 1865 Nottingham capital was skilfully spirited away to a remote and unproductive Welsh quarry by unscrupulous company promoters. Mr. J. W. Gregory, a retired lace manufacturer, and other investors, mostly from Nottingham, which presumably was suitably distant, were promised 40 to 50 per cent. on an investment in a slate quarry in Pembroke(34).

Investment by Individuals

So far we have considered, albeit rather briefly, the transfer of funds in two ways : through the banks and through investment in specific companies. But one may also examine such flows of capital by referring to the activities of individual investors. Thus, just as Smith and the Wrights invested in turnpike trusts, navigations and iron-founding in the 18th century, so many of Nottingham's leading manufacturers in the 19th century supported railway development. Richard Birkin, who founded a lace manufacturing business in 1827, became a Director of the Midland Railway, and his son later became a Director of the Great Northern Railway. Another example is William Hollins, the cotton spinner and hosiery manufacturer, who left railway shares with a nominal value of £20,000 in 1865(35).

In this way Birkin and Hollins transferred large sums from the traditional manufacturing industries to other fields of investment, but other transfers, on a lesser scale, also occurred. We may quote the example of two Frenchmen, Caron and Duclos, who are recorded as having divided their joint holding of railway shares on the dissolution

of their small lace manufacturing partnership in 1853([36]). Instances also arose of temporary transfers of capital as, for instance, when James Morley, the hosier, leased coal mines at Greasley in 1851, and at Watnall in 1852, from the Duke of Rutland and Lancelot Rolleston, in order to raise a mortgage for the furtherance of his normal business([37]). In 1858 these properties, including 30,000 bricks, eight steam-engines and several miles of railway, were auctioned by Morley's assignee([38]). Property development in Nottingham also understandably derived its capital from local industry. A leading figure in this field in the mid-nineteenth century was Lewis Heymann, the lace manufacturer, a principal trustee of the Nottingham Benefit Building Society([39]).

Conclusion

Although the whole nexus of location factors is not examined in this survey, it has been shown that, through the medium of banks and joint-stock companies, the flow of surplus funds from established industries and firms played an important part in stimulating and nurturing further industrial development in Nottingham. Such a continuous process of accumulation and investment may be regarded as an important aspect of the general concept of industrial momentum, and as such it should not, therefore, be overlooked in geographical studies of industrial location.

NOTES.

(1) H. T. Easton, *The History of a Banking House,* (1903).

(2) Note issues may be expressed as a percentage of total liabilities to the public. This is a measure of the extent to which a banker is making use of his deposits. See L. S. Presnell, *Country Banking in the Industrial Revolution,* (1956) p.164.

(3) Easton, op. cit., passim.

(4) Nottingham Central Library, Mss. Acc. No. 479, Folios 58, 69, 77, 85 and 93.

(5) Nottingham Central Library, Mss. Acc. No. 5586, Diary of Ichabod Wright II, grandson of the founder.

(6) Harriet, daughter of Ichabod II, married "Mr. Samuel Jones Loyd (sic) the only son of Mr. Lewis Loyd, both being bankers in the City and also Principal Partners in the great Banking House of Jones & Co. of Manchester". Ibid., 10th August, 1829.

(7) See article on Wright's Diary by J. D. Chambers in *Nottingham Journal,* 29th June 1949.

(8) Diary, February 1830.

(9) Register of Public Companies, No. 26306.

(10) S. Lloyd, *The Lloyds of Birmingham,* (1907) p.169.

(11) J. Blackner, *History of Nottingham,* (1815) p.252.

(12) Diary, 10 December 1825.

(13) Deed of Settlement, 19 October 1836, Register of Public Companies, No. 2,819.

(14) Register of Public Companies, No. 2,819, 9 October 1866.
Nominal capital: 60,000 shares × £10 (£600,000). Called-up capital: 38,254 × £3 (£114,762).

(15) Quoted by T. E. Gregory, *The Westminster Bank Through a Century* (1936) p.129

(16) Register of Public Companies, No. 19,862, 9 August 1874.
Nominal capital: 10,000 × £50 (£50,000). Called-up capital: 7,652 × £25 (£203,500).

(17) Quoted by W. F. Crick and J. E. Wadsworth, *A Hundred Years of Joint Stock Banking* (A History of the Midland Bank) (1935) p.263.

(18) Register of Public Companies, No. 2,346, 2 February 1866.
Nominal capital: 20,000 × £50 (£1 million). Called-up capital: 9,255 × £7-10-0 (£69,362-10-0).

(19) Registered as Nottingham and District Bank Ltd., on 7 December 1889, changing its name to Midland Counties District Bank Ltd. on 22 February 1899.

(20) Register of Public Companies, No. 30,358, 15 April 1890.
Nominal capital 20,000 × £30 (£600,000). Called-up capital: 10,000 × £5 (£50,000).

(21) Hart, Fellows amalgamated with Lloyds in 1891. Wrights joined with Capital and Counties in 1898, which in turn united with Lloyds in 1918. Moore & Robinson amalgamated with Capital & Counties in 1901 and were also absorbed by Lloyds in 1918. Smith's united with Union Bank of London in 1902 and with the National Provincial in 1918. The Nottingham & District amalgamated with Birmingham District & Counties in 1903 and with Barclays in 1916. The Nottingham Joint Stock in 1905 joined the London City & Midland, which became the Midland in 1924. The Nottingham and Nottinghamshire amalgamated in 1919 with London County Westminster & Parrs, which became the Westminster in 1924.

(22) 18 & 19 Victoria, c.133. See H. A. Shannon, The Coming of General Limited Liability, *Econ. Hist.*, II (1931) 267-291.

(23) Register of Public Companies, No. 43,745, 9 August 1895.
Nominal capital: 4,000 × £50 (£200,000). Called-up capital: £80,350.

(24) Nottingham & Notts. Illustrated, 1898, p.50.

(25) Register of Public Companies, No. 24,583, 3 November 1887.
Nominal capital: 25,000 × £5 (£125,000). Calls received: £18,414-10-0.

(26) Register of Public Companies, No. 28,064, 4 May 1889.
Nominal capital: 20,000 × £1 (£20,000). Called-up capital: 8,004 × £1 (£8,004).

(27) Register of Public Companies, No. 60,688, 27 June 1899.
Nominal capital: 480,000 × 2/6 and 60,000 × £1 (£120,000). Taken up capital: £31,152-7-6.

(28) Register of Public Companies, No. 35,286, 18 April 1892.

(29) Register of Public Companies, No. 18548, 14 November 1883.

(30) Register of Public Companies, No. 18548, 14 January 1889.

(31) Register of Public Companies, No. 27,657, 22 March 1899.

(32) Register of Public Companies, No. 10,717.

(33) Register of Public Companies, No. 5,981.

(34) Nottm. Public Library, Mss. Acc. No. 6024 Elsey v. Parsons.

(35) Nottm. Central Library, Mss. Acc. No. 6024 Memorandum to Will.

(36) Nottm. Central Library, Mss. Acc. No. 6715 Deed of Dissolution.

(37) Nottm. Central Library, Mss. Acc. No. 6040 Lease.

(38) Nottm. Central Library, Mss. Acc. No. 6177 Public Notice.

(39) Nottm. Central Library, Mss. Acc. No. 3991 Mortgage of 1851.

THE 1801 CROP RETURNS FOR SOUTH LINCOLNSHIRE

D. B. Grigg.

The 1801 crop returns* survive for parishes covering 77 per cent. of the total area of South Lincolnshire (the Parts of Kesteven and Holland), and thus enable a valuable picture of the agriculture of the period to be obtained. The origin and validity of the 1801 crop returns have been discussed by a number of writers([1]) and only the major points will be mentioned here. It is generally agreed that while the returns underestimate the actual acreages, they do accurately reflect the proportions under each crop in individual parishes. Unfortunately the returns were far from complete. No returns were made of arable land lying in fallow or of land under temporary grasses or permanent grass. In South Lincolnshire returns were made of wheat, barley, oats, rye and potatoes separately; estimates of the acreage under rape and turnips were in some cases given as an undivided figure. However, as rape was confined to the fenland and few turnips were grown in the fenland, this difficulty is easily overcome. In a few parishes peas and beans were returned as one figure.

The most striking feature revealed by the maps of crop distribution (Figs. 2 and 3) is the close relationship between crop selection and soil type. Unfortunately a map of soil types in South Lincolnshire is not available, but as the chief regional variations in soil type are directly related to differences in parent material, the map of solid and drift geology (Fig. 1) gives a reasonable indication of them. The close relationship between soil type and crop selection is not surprising. In 1801 few parishes remained in open field and farmers were thus freed from traditional rotations. On the other hand, in spite of the progress of enclosure farming methods were still backward([2]), and farmers tended to grow the crops that were most suitable for the local soil type. However, after 1820 there was a rapid improvement in farming methods, and a declining dependence on soil type in crop selection. This is best illustrated by the changes in the distribution of wheat. In 1801 wheat was not grown in any quantity on the limestone or gravel soils of South Lincolnshire (Fig. 1), for without heavy fertilising these soils gave a poor yield. On the peat soils of the fenland the wheat crop was of very poor quality. Thus wheat tended to be confined to the clays, which were suited to its cultivation. However, by 1850 there had been marked improvements in the farming methods of both the Heath and the fen, including the introduction of heavy manuring and the use of artificial fertilisers. This freed farmers from close dependence on "inherent" soil characteristics, and one consequence was that by mid-century wheat was the leading crop in most parts of South Lincolnshire, and by 1875 was the main crop in all but a few parishes.

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*The high corn prices of 1800 prompted a government inquiry into the acreage under corn in the country. Parish clergymen made estimates of the areas under certain crops in their parishes and these were forwarded, grouped by the dioceses, to the Home Office.

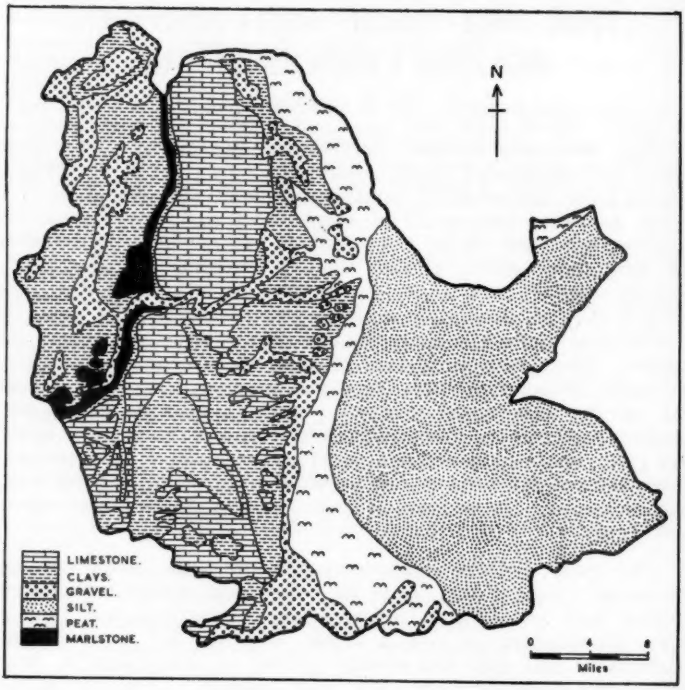


Figure 1
Simplified geology (solid and drift) of South Lincolnshire.

The totalled returns for South Lincolnshire are shown in Table 1. The most striking feature is the dominance of grain crops, which occupied three-quarters of the whole recorded area. Of the grains, oats was the most important, occupying one-third of the recorded acreage. Oats was used almost exclusively as a fodder crop, particularly for horses. Its significance in South Lincolnshire, however, was not solely due to the importance of livestock farming in the area. Oats was regarded as the ideal crop to grow on land that was being ploughed for the first time, and at the end of the eighteenth century a great deal of waste land in South Lincolnshire was being reclaimed. The general procedure was to pare and burn the sward, grow turnips or rape for one year, and then oats for several years. This accounts for the enormous oats acreages in the fenland, where recently drained land was being cultivated for the first time. The peat and skirty soils of the fens had a high nitrogen content, and when first ploughed were unsuitable for wheat. The excessive nitrogen content gave a wheat more straw than grain. Thus the usual practice was to grow a series of oats crops to exhaust this initial fertility. Oats was also locally important on the limestone Heath, where wasteland was being ploughed under the stimulus of high grain prices. However, the acreage under oats on the Heath was not comparable with that on the fenland, where 55 per cent. of the arable was occupied by oats. In parts of the fenland over four-fifths of the recorded

acreage was in oats. Not all this crop was locally consumed. In 1812 one-third of all the oats imported into London for stables came from Boston(4).

TABLE 1

THE 1801 CROP RETURNS FOR SOUTH LINCOLNSHIRE

Crops	*Acreage*	*Percentage of Total Acreage*
Wheat	24,566	21.2
Barley	24,507	21.2
Oats	35,549	31.8
Peas and Beans	9,419	8.1
Turnips and Rape	18,697	0.3
Rye	347	0.3
Potatoes	1,407	1.3
	115,492	100.0

Oats grew on poor, acid soils more successfully than wheat or barley; it was therefore the leading crop in the parishes of north-west Kesteven where the arable land was on fluvio-glacial gravels. Rye, a poor-soil crop too, was also grown in small quantities in this region.

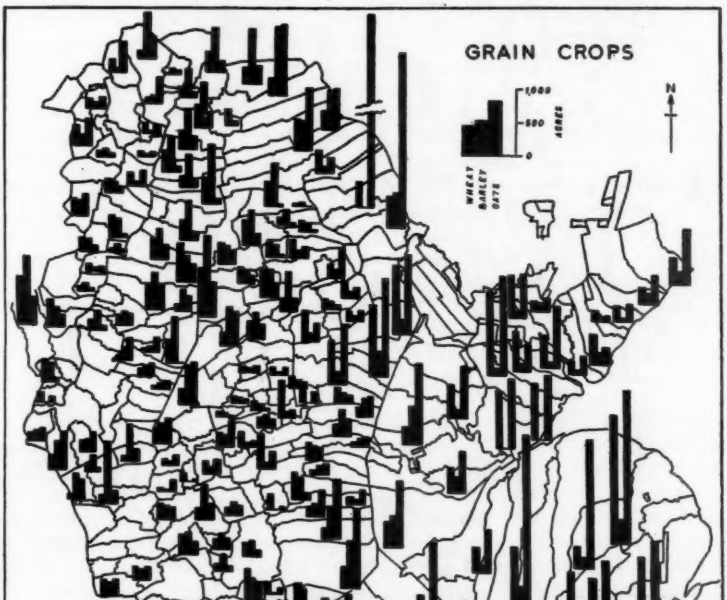


Figure 2

The distribution of grain crops in South Lincolnshire in 1801.

Wheat and barley both occupied a fifth of the arable land of South Lincolnshire, but had very different distributions. Barley was grown primarily for malting, and the best soils for malting barley in South Lincolnshire were to be found on the limestone Heath, where the crop occupied a third of the arable. Elsewhere barley was grown in small quantities as a feed crop. The fen soils gave a poor malting barley, as did the clay soils in South Lincolnshire. However, Figure 2 shows an apparent anomaly, for barley was the leading crop in a number of parishes on the Lias clay plain of west Kesteven. This was due to the nearness of the Newark Maltsters. West Kesteven farmers limed their soils heavily—an unusual practice at this time—and according to Arthur Young, produced a malting barley comparable with that produced on the limestone soils of the Heath. But in wet years the undrained clays gave a poor quality barley, and on a number of occasions in the 1800's, the maltsters refused the crop(5).

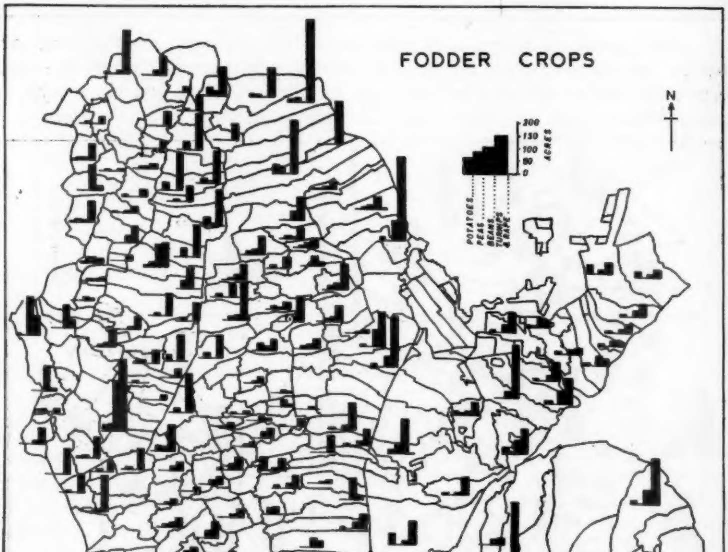


Figure 3
The distribution of fodder crops in South Lincolnshire in 1801

Wheat was widely grown in South Lincolnshire, but nowhere was it as dominant in the rotation as barley on the Heath or oats in the fenland. In the eighteenth century the claylands of England were the traditional wheat producers, and this was true of South Lincolnshire. Wheat was the leading crop in some of the parishes of west Kesteven,

on Lias clay; in south-east Kesteven, on boulder clay; and in the fenland on the heavy silts. In 1801 it was of growing importance in the interior fenland. While wheat was grown on the Heath and on the gravel soils of north-west Kesteven, it was only in small quantities; the thin limestone soils gave a low yield, and it was not until the adoption of artificial fertilisers and oil-cake feeding after 1820 that wheat replaced barley and oats in this area.

Fodder Crops

In 1801 the claylands of South Lincolnshire—west Kesteven, south-east Kesteven, and the heavy silts of the fenland—were mainly grassland, and a relatively small proportion of the arable land of any part was devoted to fodder crops. Turnips were the most important fodder crop, rather surprisingly considering the generally backward state of farming in the area. They were essentially a light land crop, and were most important in South Lincolnshire on the Heathland and the gravel soils of north-west Kesteven. In both these areas they occupied a fifth of the arable land, and on some farms they had been introduced as part of the Norfolk four course rotation, being fed off by sheep. However this was unusual. They were generally poorly cultivated, and were often followed by several white grain crops. Outside the light land areas they were rarely significant. The claylands lacked any form of under-drainage at this time and this prevented the successful growing of turnips. The crops could not be fed off by sheep because the animals "poached" the wet soils (destroyed their good tilth) and also ran the risk of foot rot. Nor was it economic to lift the crop in a wet year. In the fenland the heavy silts suffered from the same disadvantages as the clays, whilst on the peat soils the turnip roots became "fangy," that is suffered from multiple development. In the fenland the turnip was only grown on the lighter silts of the Marshlands. In the clay areas the turnip was sometimes grown on river gravels, but beans were usually the main fodder crop. Peas were of minor importance, and were confined to the lighter soils—the Heath and gravel areas

Other Crops

The only other crop of any significance in the 1801 returns was potatoes. In 1801 the potato was not yet of much importance in England, and was only recorded in any substantial amount in the returns for Lincolnshire and Lancashire. Down to the 1790's it was largely grown for fodder, but the high wheat prices of that decade led to its being grown for human consumption. In South Lincolnshire it was grown mainly in the fenland. Although the acreage expanded during the 1790's—one Spalding farmer had 200 acres—it still occupied only a negligable proportion of the total acreage(6). It was most important in Skirbeck Hundred, north-east of Boston, where 5 per cent. of the arable was occupied by potatoes. It was this region which later in the nineteenth century was to become the major Lincolnshire potato growing area. Small quantities of other crops were grown in the fenland—flax, hemp, mustard seed and woad—but they covered a small proportion of the total acreage although they attracted a great deal of attention from contemporary writers(7).

Some Anomalies

The preceding description bears out the statement that there was a close relationship between soil type and crop selection in 1801 in South Lincolnshire. However Figs. 2 and 3 do contain three apparent anomalies. In the central Heath, a number of parishes grew wheat as their main crop, although wheat gave a poor yield there, and the soils could produce a good malting barley. Similarly, in the parishes around Deeping Fen the main fodder crop was beans, although the gravel soils were ideal for turnips. In both cases the anomaly was due to the persistence of open fields. Wheat was generally the main crop in the open field system, regardless of the soil type, while it was impossible to grow turnips on unenclosed land unless a special agreement was made between the farmers and cottagers of the village. Thus these two anomalies illustrate the point made originally. Where the open field system persisted, there was not yet an adjustment between crop selection and soil type. On the other hand the third anomaly—the growing of barley on the Lias clays of west Kesteven illustrates the fact that as farming methods improved, farmers were less dependent on soil type in their selection of crops. Thus for a short period between the elimination of the open fields and the general adoption of improved farming methods, crop selection in South Lincolnshire showed a remarkable adjustment to soil type.

NOTES

(1) D. B. Grigg, *Agricultural Change in South Lincolnshire, 1790-1875*, unpublished Ph.D. thesis, Cambridge (1961). This study contains a more detailed analysis of the farming of the period, together with references.

(2) H. C. K. Henderson, Agriculture in England and Wales in 1801, *Geographical Journal*, 118, 3 (1952) 228-345.
W. E. Minchington, Agricultural Returns in the Napoleonic Wars, *Agricultural History Review*, 1, 1, (1953), 40.

(3) The 1801 returns can be inspected in the Public Record Office, H.O. 67/Lincoln. I am grateful to Dr. H. C. K. Henderson for advice on the use of the returns.

(4) P. Thompson, *A History of Boston*, (1856), p.109.

(5) A. Young, *A General View of the Agriculture of the County of Lincoln*, (1799), p.260. *Annals of Agriculture*, 31, (1799), p.203.

(6) A. Young, op. cit., pp.152, 147. *Annals*, 21, (1795), p.120.

(7) A. Young, op. cit. pp.147, 157, 161, 197, 198. *Annals*, 45, p.558. *Communications to the Board of Agriculture*, 55 (1805), p.187.

A ROAD TRAFFIC CENSUS AT TRENT AND CLIFTON BRIDGES, NOTTINGHAM

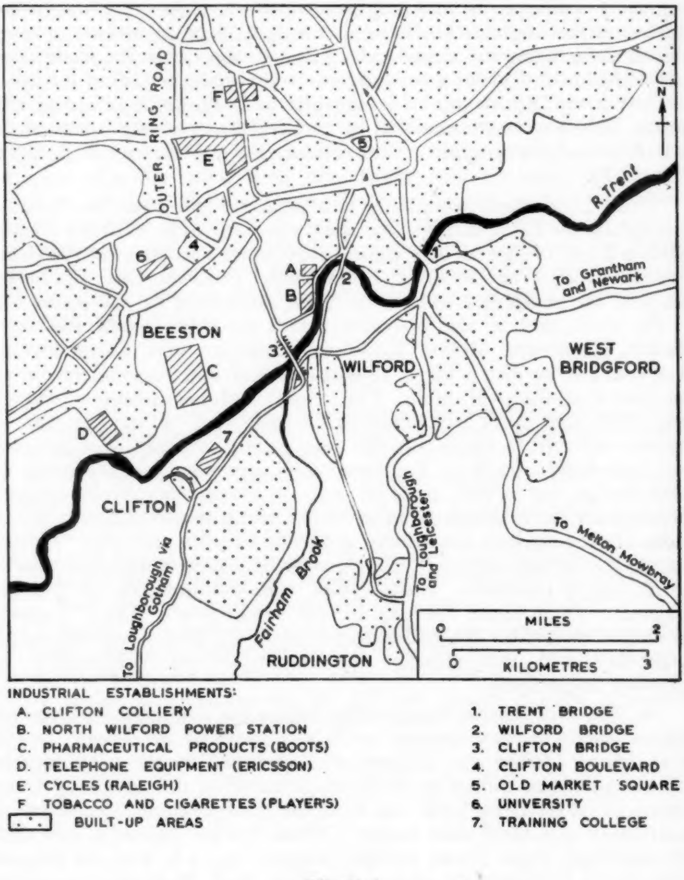
R. H. Osborne

Between 6 a.m. and 10 p.m. on Tuesday, 20th June, 1961, geography students of Nottingham University and of the newly-established Nottingham Teachers' Training College carried out a census of road traffic using the Trent and Clifton Bridges over the River Trent at Nottingham. Similar investigations were made at Trent Bridge by the University Department of Geography in 1939, 1949, 1950 and 1954, and the results were summarised by D. R. Mills in earlier issues of *The East Midland Geographer* (No. 2, Dec. 1954, 44-6, and No. 3, June 1955, 43-7).

Until 1958 there were only two road bridges over the Trent at Nottingham :—Trent Bridge, the main crossing, and Wilford Bridge, which is a toll bridge of only minor importance located a short distance upstream from Trent Bridge. Trent Bridge links the City of Nottingham with the residential suburb of West Bridgford on the south bank of the river, and it also provides access to main roads leading to Newark, Grantham, Melton Mowbray, Leicester and Loughborough. As a result it carries a large volume of local and regional traffic and also some long-distance traffic. The origins and destinations of vehicles using the bridge were not, however, investigated in any of the five censuses referred to above. In the four earlier censuses separate totals were recorded for each of the three roads converging on the south end of the bridge, but in 1961 such an analysis was not practicable owing to a reconstruction of the junction in recent years, which makes it difficult to identify the various constituent traffic-flows with precision. In 1961, also, the distinction hitherto made between light lorries and heavy lorries was no longer observed. Pedal cycles were excluded as on previous occasions. Once again the day of the week chosen was a Tuesday; this choice eliminates the inclusion of week-end traffic and also avoids market-day and early-closing day conditions on Wednesday and Thursday respectively.

In 1951 Nottingham Corporation began the building of a large new housing estate in open country at Clifton, south of the Trent. In 1952 the parish of Clifton and Glapton was absorbed by the City, together with the suburban village of Wilford, situated in the adjoining Urban District of West Bridgford. In 1958 the Corporation completed the construction of a third road bridge, Clifton Bridge, located a mile and a half upstream from Trent Bridge (Figure 1). (A note on the new bridge, by K. C. Edwards, appeared in *The East Midland Geographer*, No. 9, June 1958, p. 45). This bridge provides a quicker and somewhat shorter route between the city centre and the growing Clifton Estate, hitherto linked to the city only by means of Trent Bridge. Clifton Bridge also offers advantages to traffic moving between the west side of Nottingham and some of the villages situated between Nottingham and Loughborough. Eventually it will be doubled in width to provide a dual carriageway, and it will also form part of Nottingham's outer ring-road system. At present this is in existence only on the northern and western

sides of the city, and its line terminates one mile north-west of the bridge (Clifton Boulevard). The bridge is at the moment connected to the ring-road only by a narrow, badly-surfaced lane crossing the flood-plain of the Trent. This route is not sign-posted for through traffic, but it is, nevertheless, used to a considerable extent, especially by workers commuting between Clifton and places of employment located on the west side of Nottingham.



INDUSTRIAL ESTABLISHMENTS:

A. CLIFTON COLLIERY
B. NORTH WILFORD POWER STATION
C. PHARMACEUTICAL PRODUCTS (BOOTS)
D. TELEPHONE EQUIPMENT (ERICSSON)
E. CYCLES (RALEIGH)
F TOBACCO AND CIGARETTES (PLAYER'S)
BUILT-UP AREAS

1. TRENT BRIDGE
2. WILFORD BRIDGE
3. CLIFTON BRIDGE
4. CLIFTON BOULEVARD
5. OLD MARKET SQUARE
6. UNIVERSITY
7. TRAINING COLLEGE

Figure 1

Location of bridges over the River Trent at Nottingham.

The 1961 Traffic Census

The traffic census of 1961 was thus the first one organised by the University Department of Geography to be held since the building of the new bridge, and, indeed, one purpose of the census was to compare the flow over both Trent and Clifton Bridges with that over Trent Bridge at the time of the previous census in 1954. Table I shows the changes that have taken place since 1954, and also incorporates the figures for 1939 and 1950.

The earlier censuses showed that between June, 1939, and June, 1950, there was no increase in the traffic-flow over Trent Bridge, indeed there was a very slight decline. This was probably due to the effect on the number of vehicles on the roads of a decade of severe petrol rationing (which, however, had just ceased at the time of the 1950 census, on 26th May) and also to the effect of the drastic war-time reduction in the output of civilian motor-vehicles, combined with restricted supplies for the home market in the years immediately after the war. Between 1950 and 1954, however, traffic at Trent Bridge grew by about 7,000 vehicles, to a total of 30,000, corresponding to an increase of 30 per cent. Some of this increase was, no doubt, due to the shift of population across the river associated with the development of the Clifton Estate, where the population had reached about 12,000 by 1954. On the other hand, it seems probable that a large part of the increase was due to growing car-ownership, especially in West Bridgford and neighbourhood, and also to a general increase in industrial and commercial activity as reflected by the increase in the number of lorries and vans.

The results of the 1961 census show that while Clifton Bridge may have absorbed some of the traffic formerly using Trent Bridge and also, presumably, the additional traffic accruing from the further development of the Clifton Estate (1961 estimated population about 25,000), there has, nevertheless, been a rise of 32 per cent. in the traffic using Trent Bridge (30,000 to 39,000 vehicles). The annual rate of increase (compound) in traffic-flow at Trent Bridge was, however, lower between 1954 and 1961 (about 4.2 per cent.) than between 1950 and 1954 (about 6.3 per cent.). This diminution in annual rate of increase could be the result of a partial deflection of traffic to Clifton Bridge or of some general slackening in the rate of increase of the number of vehicles needing to cross the river, or the result of both factors in conjunction. It may also be of significance that the population of West Bridgford grew much less rapidly than that of Clifton during the years referred to (24,000 to 27,000) and it should also be noted that the degree of car-ownership in 1954 in West Bridgford would already have been at a fairly high level in view of the socio-economic characteristics of its population. If, however, the flows over the two bridges are combined (53,000) the total increase in traffic compared with the Trent Bridge flow in 1954 is 23,000, and the overall rate of growth of 77 per cent gives an annual rate of about 8.8 per cent. This is a rate more than one third higher than the annual growth rate for Trent Bridge between 1950 and 1954.

At Trent Bridge cars and motor cycles (including scooters and mo-peds) showed the highest rate of increase (44 and 39 per cent. respectively), while there was only a small increase in the number of buses (service and special) and an increase of 15 per cent. in lorries and vans.

TABLE I

ROAD TRAFFIC CROSSING THE TRENT AT NOTTINGHAM, 1939-1961

Type of Vehicle	Trent Bridge				Clifton Bridge	Both Bridges	1954 total as per cent of 1950	1961 total as per cent of 1954 (Trent)	1961 total as per cent of 1954 (Both)
	June 1939	June 1950	October 1954	June 1961	June 1961	June 1961			
	(vehicles)								
Cars	15,636	12,559	16,269	23,365	7,333	30,698	129.4	143.6	188.6
Lorries and Vans	5,141	7,282	9,747	11,233	3,417	14,650	133.9	115.2	150.3
Buses	1,681	1,887	2,014	2,159	387	2,546	106.9	107.1	126.4
Motor cycles ..	1,011	1,364	1,948	2,717	2,481	5,198	142.8	139.4	266.8
Total ..	23,469	23,092	29,978	39,474	13,618	53,092	129.8	131.6	177.1

The addition of the Clifton Bridge traffic raises the total number of both cars and commercial vehicles by about 30 per cent., the number of buses by 18 per cent. and the number of motor cycles by no less than 91 per cent. The number of motor cycles using Clifton Bridge is, in fact, nearly as high as at Trent Bridge. It will also be noted that the total number of vehicles using Clifton Bridge in 1961 (13,600) was probably about half the total using Trent Bridge in the early 1950's. Clifton Bridge is already carrying an impressive amount of traffic, therefore, and it will be interesting to see what additional traffic will result from its eventual doubling in width and integration in the outer ring-road system of Nottingham (and the trunk-road system of the nation), and to what extent this will affect the volume at Trent Bridge.

Trent Bridge

Figures 2(a) and 2(b) show the daily rhythm of the inward and outward traffic flows at both bridges. The number of vehicles is shown by a column for each quarter-hour period, cars being distinguished from other vehicles. Cars constitute 57 per cent. of all traffic at Trent Bridge and 54 per cent. at Clifton Bridge. Figures 2(c) and 2(d), showing lorry and van traffic only, should be viewed in conjunction with Figures 2(a) and 2(b).

Inward Traffic using Trent Bridge reaches a morning peak between 7.45 and 9.30, when vehicles are entering the city at rates of well over 400 in each quarter-hour, with the figures rising to 550-600 in each of the quarter-hours between 8.15 and 9.0. Since the greater part of this traffic is associated with the journey to work (although the number of lorries and vans also increases after 7.30) it is not surprising that the percentage of cars to total traffic rises to 70 per cent. and over between 8.15 and 9.30. Buses are also more numerous at this time of the morning, entering the city at rates of 20-35 per q.h. between 7.30 and 9.15.

As the diagram shows, the number of vehicles entering Nottingham falls away after 9.0 to rates of about 300 per q.h. between 9.45 and 11.45, while at the same time the proportion of cars to the total also falls. This is due to a fall in the number of cars and to a slight rise in the number of commercial vehicles. An exception occurs in the period 10.15 to 10.30, when there is a brief increase in cars. Perhaps this is due to the shopping habits of car-owning West Bridgford housewives.

The general trend continues downwards until 12.45, after which time there is an upward trend to the second peak of the day, occurring between 1.45 and 2.45, with vehicles entering at the rate of about 500 between 2.0 and 2.15. This peak is of a shorter duration than the morning peak, but exhibits a similar rise in the proportion of cars, and it is obviously related to the after-lunch return to work in Nottingham by persons living in West Bridgford and district. Commercial traffic, as might be expected, shows a fall after 12.15, but it rises again after 2.0.

After 2.45 traffic fluctuates around 300 per q.h. until 4.15. From then onwards there is a build-up of traffic to a third peak period between 5.0 and 5.30, followed by a secondary peak between 6.0 and 6.15, but the totals fall short of those for the two earlier peak periods.

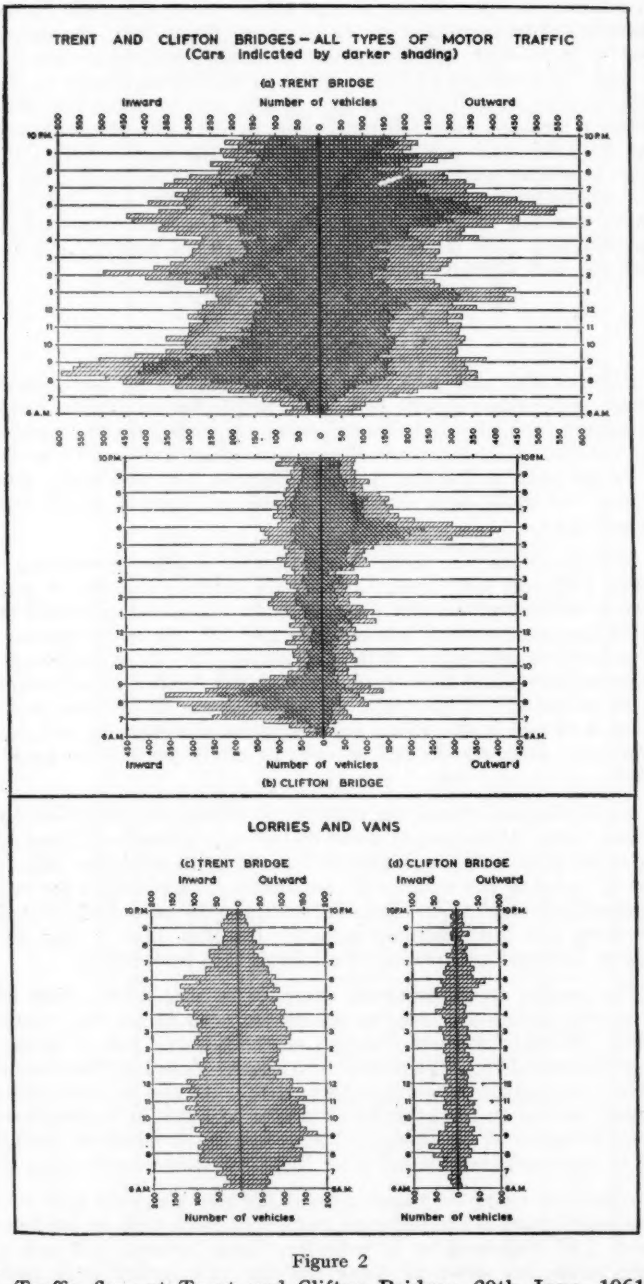


Figure 2

Traffic flow at Trent and Clifton Bridges, 20th June, 1961

This increase in traffic concerns all categories and no doubt largely relates to a return to the city by car or commercial vehicle on the part of persons who have been working outside the city. The flow of buses rises to the 25-40 range per q.h. between 4.30 and 6.30.

From 6.15 onwards until 7.45 traffic fluctuates between 300 and 350 per q.h., with a slight peak between 7.0 and 7.15. Traffic in this early-evening period is probably associated with visits to Nottingham for entertainment. After 7.45 there is a distinct fall in traffic, which then shows an irregular downward trend to under 200 vehicles per q.h. between 9.45 and 10.0. Cars reach a high proportion of this reduced traffic flow in this latter part of the day, in contrast to the low proportion in the early-morning period before 8 a.m.

Outward Traffic, as might be expected, shows a different pattern although a largely complementary one. Traffic gradually increases between 6.0 and 8.0 a.m., and reaches a range of 330-380 vehicles per q.h. between 8.0 and 9.15. There are minor peaks between 8.0 and 8.30 and between 9.0 and 9.15, however, the latter being associated with an increase in commercial vehicles. From then on until mid-day traffic remains steady at 300-330 per q.h., with the ratio of cars to other vehicles never rising much above 50 per cent.

Between 12.0 and 12.15 the number of vehicles rises to 360 per q.h. owing to an increase in cars. After 12.15, however, there is a lunch-time decline in commercial vehicles, which remain at a lower level until 2.15. Nevertheless, the first marked peak of the day occurs between 12.30 and 1.15, when the total number of vehicles reaches 425-450 per q.h., as the result of a doubling of the morning rate of flow of cars. This obviously reflects the outward journeys of persons leaving the city for lunch at home in West Bridgford and district.

Between 1.15 and 4.0 traffic falls to 250-300 vehicles per q.h. This is a distinctly lower level than during the morning and may suggest that fewer persons are now leaving the city by car and lorry to perform work or make visits of some kind in the surrounding area. The fall is greater for commercial vehicles, however, than for cars. From 4.0 onwards the volume of traffic builds up and the car ratio rises again as persons begin to return home from city schools, offices and factories, the peak being reached between 5.0 and 6.30, when over 450 vehicles per q.h. are leaving the city. Betwen 5.30 and 6.0 the rate reaches nearly 550. Buses are also numerous during the early-evening outflow from the city and vary between 20 and 30 per q.h. between 4.0 and 6.30. A similar number of buses also leaves the city between 7.0 and 9.30 in the morning, it may be noted, although in this case, of course, most of the buses are travelling out to bring workers into the city. After 6.30 p.m. the volume of traffic falls to a level of about 200 vehicles between 8.0 and 8.15. Traffic then gradually rises again to 300 per q.h. by 9 p.m., after which it falls once more to the 200 level, with a very high ratio of cars. Again this late-evening feature can be contrasted with the very low car ratio of the early morning.

The combined effect of the inward and outwards flows is to produce three major peak periods :—(*a*) The morning peak period, with a large inflow and a smaller, but nevertheless considerable, outflow, which falls to 60 per cent. of the inflow between 8.15 and 8.30; before 7.30 and after 9.30 the two flows are similar in size. (*b*) The lunch-time peak of

smaller volume, consisting of an outward movement followed by an inward movement. (*c*) The early-evening peak, extending over rather a longer period than the morning peak and with the inward flow falling to 55 per cent. of the outward flow between 5.45 and 6.0 p.m. The flows are approximately equal before 5.30 and after 6.30.

Inward traffic reaches a rate of one or more vehicles per two seconds (450 per q.h.) between 7.45 and 9.15, and again between 2.0 and 2.15, but falls a little short of this level between 5.0 and 5.30. Outward traffic reaches a rate of 450 or more between 1.0 and 1.15 p.m. (although falling somewhat short of this between 12.30 and 1.0) and again between 5.0 and 6.30. The highest inward flow occurs between 8.15 and 8.30 (592), and the highest outward flow between 5.45 and 6.0 (544). The highest combined flows occur between 8.15 and 8.30 (952 vehicles), 8.30 and 8.45 (905) and 5.30 and 5.45 (906). All these totals correspond to rates of over one vehicle per second.

Clifton Bridge

Inward Traffic is greatest between 7.0 and 9.0 in the morning. The evidence suggests that there are two distinct inflows, however, separated by a slack period between 8.0 and 8.15. These may, perhaps, be called the "manual worker" inflow (7.0-8.0) and the "white-collar worker" inflow (8.15-9.0). The proportion of cars is lower and the proportion of motor cycles higher between 7.0 and 8.0 than between 8.15 and 9.0. Indeed between 7.0 and 7.30 the number of motor cycles exceeds the number of cars. At Trent Bridge, on the other hand, there is no similar lull between 8.0 and 8.15, and the build-up in the volume of traffic becomes really marked only after 7.30, *i.e.,* half an hour later than at Clifton Bridge. While there may well be a number of manual workers travelling by car or motor cycle in the earlier part of the Trent Bridge morning peak period, it is, of course, true to say that West Bridgford and district is one of Greater Nottingham's foremost residential areas for professional and clerical workers. At the 1951 census of population the proportion of males classified in Social Classes I and II in West Bridgford was about three times the proportion in these classes in Nottingham itself, while the proportion in Social Classes IV and V was well under one-third of the city's. Clifton, consisting essentially of the city's post-war housing estate, probably has a fairly high proportion of manual and unskilled workers, who begin work earlier than the professional and clerical groups.

The periods with the greatest inward traffic flow at Clifton Bridge are 7.30-8.0 (300-330 vehicles per q.h.) and 8.15-8.30 (360). After 9 a.m. the volume per q.h. falls away to a level fluctuating around 60 between 9.30 and 1.15. There is then a minor peak between 1.15 and 2.15, associated with a significant rise in the number of cars and motor cycles. This is obviously a reflection of the return journey to work after lunch at home. In the quarter-hour with the largest volume of flow (1.30-1.45) the number of vehicles reaches 120. The after-lunch inflow is, however, a smaller proportion of the morning inward flow than is the case at Trent Bridge, as may be seen from Figure 2; presumably, therefore, the proportion of commuters lunching at home is higher at West Bridgford than at Clifton. This again may reflect the occupational and social differences between these two districts.

Afternoon traffic falls after 2.15 to a range in volume of 55-100 vehicles per q.h., but after 5.0 the flow rises sharply as the third peak period of the day is reached. This lasts until 6.0 and has rates of between 120 and 140 vehicles per q.h. This increase in traffic probably relates to a return of cars and lorries to the city at the end of the working day. Thereafter the flow falls to about 100 per q.h. between 6.0 and 6.15 and then remains at this level until 7.30, after which there is a decline to 60 per q.h. between 9.15 and 9.30. After 9.30 there is some increase in traffic owing to higher numbers of cars and motor cycles, possibly indicating an inward movement of night-shift workers or the return to the city of evening visitors. As at Trent Bridge the evening traffic shows a higher car ratio to total traffic than during the daytime.

Outward Traffic using Clifton Bridge also shows three peak periods, of which by far the most marked is that coinciding with the journey home from work in the evening. Morning traffic rises to levels of 80-140 vehicles per q.h. between 7.45 and 9.0, and in part at least may relate to persons working in Clifton and nearby villages but living on the Nottingham bank of the river. The number of motor cycles is highest between 7.45 and 8.0 and the number of cars between 8.30 and 8.45. Between 8.0 and 8.30 traffic falls slightly owing to a decline in the number of motor cycles and the absence of any increase in the number of motor cars. Between 9.0 and 12.30 the level of traffic drops to 50-80 per q.h. A second peak period occurs between 12.30 and 1.15, when the flow reaches 100-120 vehicles per q.h., largely due to an increase in cars and motor cycles. This traffic is no doubt connected with the journey home for lunch; as we have seen, however, lunch-time commuting seems to be much less important than at Trent Bridge.

Traffic does not exceed the 100 vehicles per q.h. rate again until 3.45, and from then on until 5.0 it fluctuates around this figure. The large homeward rush occurs between 5.0 and 6.30. Cars and motor cycles then increase greatly and flows of 390-410 per q.h. are achieved between 5.30 and 6.0. In this half-hour period cars, motor cycles and commercial vehicles all reach their largest flows of the day. Thereafter the volume of traffic shows a steady fall to under 80 vehicles per q.h. after 8.45.

Comparison of the Two Bridges

Some points of similarity or contrast have already been indicated. The quantitative differences in traffic-flow are shown in Table 1, and further figures are presented in Table 2. The chief features of the two bridges may be summarised briefly as follows:—Trent Bridge carries three times the traffic carried by Clifton Bridge. Cars constitute much the same proportion of total flow at both bridges, and so also do commercial vehicles. Motor cycles are relatively more important at Clifton, however. Both bridges show three well-marked peak periods, associated respectively with the morning journey to work, the lunch-time journey home and back again, and the evening return home from work. Peak period traffic forms a much larger element of total traffic at Clifton Bridge than at Trent, however, and the peak period begins earlier in the morning. The lunch-time traffic is relatively less important at Clifton than at Trent. As might have been expected *a priori* Clifton Bridge is seen to be largely a commuters' bridge serving a predominantly working-class suburb, while Trent Bridge is a more "general purpose"

bridge also carrying a heavy commuting traffic of a more middle-class character. With the full linking of Clifton Bridge with Nottingham's outer ring-road system it may be anticipated that its total volume of flow will increase. The proportion of commuters' traffic may then possibly fall, but at the same time the volume of such traffic may well increase owing to the continued growth of population at Clifton and to the upward trend in car ownership.

TABLE 2

COMPARISON OF TRAFFIC AT TRENT AND CLIFTON BRIDGES

	Trent	*Clifton*
Cars as per cent of all traffic	56.7	53.8
Cars and motor cycles as per cent of all traffic	66.1	72.1
Cars, motor-cycles and buses as per cent of all traffic ..	71.5	74.9
Lorries and vans as per cent of all traffic	28.5	25.1
Motor-cycles as per cent of cars and motor-cycles ..	10.4	25.3
Average daily flow per minute, all traffic	41.1	14.2
Average daily flow per quarter-hour, all traffic	617	213
Average flow per quarter-hour during morning peak period (all traffic)[1]	826	361
Average flow per quarter-hour during evening peak period (all traffic)[2]	864	442
Morning peak period average flow as per cent of average daily flow, per quarter-hour	134	169
Evening peak period average flow as per cent of average daily flow, per quarter-hour	140	208

[1] Morning peak period here defined as 7.30 to 9.30 for Trent Bridge and 7.0 to 9.0 for Clifton Bridge.

[2] Evening peak period here defined as 5.0 to 6.30 for both bridges.

EAST MIDLAND RECORD

New Accommodation for the Department of Geography

The formal opening of the Social Sciences and Education Building, in which the Department of Geography has its first permanent home designed and equipped for the purpose, took place on Friday, November 10th, 1961. A meeting held in the Education lecture theatre was addressed by the Home Secretary, the Rt. Hon. R. A. Butler, C.H., M.A., LL.D., with the Chancellor of the University presiding, supported by the Vice-Chancellor. Guests of the Department on this occasion were Dr. H. C. K. Henderson, representing the Institute of British Geographers, Mr. G. E. Hutchings (President) and Dr. Alice Garnett (Hon. Secretary), representing the Geographical Association, and Mr. A. G. Powell (Ministry of Housing and Local Government), representing graduates of the Department. Representatives of the present students also attended. Earlier in the day Mr. Butler, accompanied by Mrs. Butler, the Vice-Chancellor and Prof. Edwards, visited the Department, devoting particular attention to the laboratories, teaching rooms and the map library.

University of Nottingham Expedition to the U.S.S.R.

In the summer vacation of 1961 a party of students under the leadership of Miss H. Palmer, of the Department of Geography, visited the Soviet Union. The party, consisting of 21 members, mainly undergraduates in Geography and Russian, travelled from Nottingham and back by coach, and between August 30th and October 1st covered over 5,000 miles. The outward journey was made *via* Brussels, Düsseldorf, Berlin and Warsaw and the return journey by way of Poprad, the High Tatra, Brno, Prague and Frankfurt-on-Main. Within the Soviet Union short visits were made to Minsk, Smolensk, Orel and Kursk, with longer periods spent in Moscow and district, Kiev and Kharkov. The itinerary provided a good opportunity to observe differing agricultural landscapes and the more obvious aspects of urban life, including housing conditions. Significant contrasts between central European Russia and the Ukraine with regard to living conditions and cultural background were also noted. At every stage of the journey the party was received with courtesy and friendliness by officials, students and the general public.

The Peak National Park Exhibition

An effective display of maps, charts and photographs relating to The Peak National Park arranged by the Park Planning Officer, Mr. John Foster, M.P.T.I., A.R.I.B.A., A.R.I.C.S., in co-operation with the Department of Geography, was held in the University from October 25th to November 13th, 1961. The characteristic features of The Peak, the first of our national parks and one of the most frequented, were admirably illustrated by this Exhibition. The display also demonstrated the careful work, both in development and preservation, undertaken by the Peak Park Planning Board and provided striking visual reminders of the responsibilities of the general public in the proper enjoyment of one of our finest pieces of landscape.

Proceedings of the Anglo-Polish Geographical Seminar, 1959

The papers presented at this joint meeting of British and Polish geographers, held in Poland in September, 1959, and attended by Professor K. C. Edwards and Dr. R. H. Osborne, have now been published in English by the Institute of Geography of the Polish Academy of Sciences as "Geographical Studies No. 25—Problems of Applied Geography" (Warsaw, 1961). The eleven articles contained in the volume (five by Polish authors and six by British) deal with various aspects of regional planning, land utilisation, physical geography in relation to industrial areas, and urban geography.

A limited number of copies are available at 25/-, from Dr. H. C. K. Henderson, Department of Geography, Birkbeck College, Malet Street, London, W.C.1.

BOOK REVIEW

The British Isles, a systematic and regional geography. By G. H. Dury. London: Heinemann, 1961. 30/-.

British university geographers seem to have been reluctant to write text-books dealing with the regional geography of their own country. The volume of regional essays edited by the late Professor Ogilvie and first published in 1928 has remained up to the present as the only regional text for advanced study. Stamp and Beaver's *The British Isles—A Geographic and Economic Survey,* first brought out in 1933 and last revised in 1954, and the late Professor Wilfred Smith's *An Economic Geography of Great Britain,* published in 1949, are not, of course, regional text-books in the conventional sense, although many of the topics dealt with are analysed on a regional scale.

Dr. Dury's book goes a long way towards filling the need for an up-to-date advanced regional geography of the British Isles, while at the same time providing in the opening third of the book some interestingly-written introductory chapters on the broad physical and economic geography of the country. In wealth of detail, however, the book does not aspire to the standard of Stamp and Beaver, and therefore cannot claim to be a companion volume of equal weight.

Apart from the moderate price important assets of the book include the well-chosen photographs illustrating the varied physical and cultural landscapes found within the British Isles, the maps of the setting and "lay-out" of a number of towns and cities, and the reproductions of sample land-use maps on the 6-inch scale. Some of the regional maps suffer from too great a reduction, and the lists of town populations at the beginning of each chapter are already out of date, however.

Criticism of the book may be made on two scores—the nature of Dr. Dury's regional division of England and the rather disquieting number of errors and omissions. The author's regions are essentially physiographic regions rather than human regions, with the result that one sometimes has the feeling that the industrial and urban geography

is being awkwardly forced into a Procrustean bed. There is, nevertheless, a frank and useful discussion of the "regional problem" in one of the chapters (pp. 163-6) and four industrial regions are, in fact, separately distinguished, two of them having chapters to themselves. One curious omission is the lack of any reference at all to the system of Standard Regions, which forms the regional framework for the publication of so many of our present-day economic and social statistics.

The East Midland region recognised by this journal (corresponding broadly to the misnamed North Midland Standard Region) unfortunately loses its coherence in Dr. Dury's hands. Instead it forms part of six of the author's regions—the Industrial Region of the West Riding, the Pennines, the Scarplands of Eastern England, the Scarplands of the South Midlands (the boundary between these two regions apparently running somewhere in the neighbourhod of Grantham), the Midland Triangle and the Fenlands.

The first of these regions is conceived as an industrial region straddling the two physiographic regions of the Pennines and the Scarplands of Eastern England, from which regions it is removed for detailed treatment in a separate chapter. Thus Mansfield and Worksop are (somewhat curiously) deemed to lie in the Scarplands, but at the same time they are considered to be part of the West Riding Industrial Region (why, incidentally, was it not given some more tactful name such as the Aire-Don Industrial Region, in view of the inclusion of parts of north Derbyshire and north Nottinghamshire?). Even here, however, one feels that while the association of Worksop (and Chesterfield) with the Sheffield industrial area can be defended, the same cannot be said for Mansfield, which has much closer connections with Nottingham.

In discussing the Midlands (p. 342) the author admits the difficulty of satisfactory demarcation, but conceives of the problem only in physiographic terms, except as regards his internal sub-division into the Midland Triangle and the Scarplands of the South Midlands. This is supported by the argument that they "differ especially in their richness in large towns." The Midland Triangle is not explicitly defined, but by implication it refers to the area of Triassic and Lower Lias rocks tapering southwards to the Severn Estuary. It does not seem particularly appropriate to choose geological limits to demarcate a highly-urbanised region of over five million inhabitants dominated by industry

One result of Dr. Dury's scheme of regional division is that a map of the Nottinghamshire oilfields appears under the Scarplands of Eastern England (p. 340), as also does the mention of the large middle Trent power-stations (some of which should, in any case, have been awarded to the Midland Triangle). Northamptonshire's footwear industry falls within the Scarplands of the South Midlands and that of Leicestershire within the Midland Triangle; thus the footwear zone of the East Midlands is severed by an irrelevant physiographic boundary. The fact that a map of urban employment in the area stretching from Nottingham to Northampton is included in the book (although placed in the Scarplands chapter and unfortunately omitting nearby Derby) may suggest that the author was aware of this drawback (p. 373).

Perhaps the attempt to formulate all-embracing regions is doomed to failure in a country like ours. Perhaps the best solution would be a

system of physiographic-agricultural regions (where a geographer like Dr. Dury is at his most effective) and a parallel system of industrial regions or city-regions incorporating subordinate rural elements and separated from each other by predominantly rural zones of greater extent. Dr. Dury seems to hint at this solution in the special treatment he accords to his West Riding Industrial Region.

In dealing with the Midlands Dr. Dury makes a number of slips, as well as some errors of omission. On pp. 358-9 we read that "Beeston . . . has recently benefited more from its motor works than from hosiery, but hosiery is still prominent at Ilkeston." Beeston's motor vehicle industry in fact disappeared before the First World War and its present industrial structure, although including textiles, is dominated by pharmaceutical products and telephone equipment. At Ilkeston mention should surely have been made of Stanton Ironworks, one of Europe's greatest iron-pipe making establishments. The various references to the development of the East Midland textile industries are disappointingly vague and telescoped. The important rubber industries of Burton on Trent and Leicester might have been mentioned amongst the subsidiary industries quoted for these towns (pp. 359, 356). Coalville and Ashby-de-la-Zouch are noted as mining towns in the South Derbyshire and Leicestershire coalfield, but not Swadlincote (p. 358). Market Harborough is confused with Melton Mowbray as regards iron-smelting (p. 375). It is not true that "Northampton, like Leicester, is surrounded by industrial satellites" (p. 374). It is misleading to suggest that "the hosiery industry merges into industrial chemistry through the production of nylon stockings" (p. 357), or that "a rapidly-growing new town is being added to the older Corby, not without difficulties of retail marketing like those which trouble Oxford and Cowley" (p. 375). Newark, Gainsborough, Grantham, Retford, Loughborough and Lichfield appear to receive no attention at all in the text. The map of the Midlands (Fig. 127, p. 343) contains several slips—"R. Thame" for "R. Tame," "N.W." for "N.E." in the key, and the Keuper Marl shading trespassing over the entire outcrop of the Lower Lias in the northern part of the map. In Fig. 135 (p. 373) Loughborough is mis-spelt and several towns are not identified.

A detailed examination of other parts of the book might well reveal similar lapses. In Scotland, for instance, there is no mention in the treatment of Ayrshire of its lace industry or of the great Transatlantic airport of Prestwick. Stirling, it should be noted, is "bypassed" (p. 261) not merely by the Forth Bridge and the Forth ferries (one of which no longer operates) but by the very much nearer Kincardine road-bridge. The rayon industry of Jedburgh closed down some years ago (p. 271). The Carron Ironworks (p. 260) has not migrated to the Clyde valley, and, far from concentrating on the home market, Hawick (p. 271) is well-known in Scotland for its lucrative exports of quality knitwear.

Dr. Dury has done a service in producing this much needed and attractively-produced text book. The fact that his regions are largely a physical geographer's regions does tend to detract, however, from its usefulness. His particular choice of regions can be justified, however; the absence of a rigorous checking of facts cannot.

R.H.O.

HIGHER DEGREE THESES AND FIRST DEGREE DISSERTATIONS

Prepared in the Department of Geography

In the University, Geography may be read as a subject in the Faculties of Arts, Law and Social Sciences, and Pure Science. Since the award of the Charter to the University in 1948 all students taking an Honours degree in Geography have been required to submit a dissertation as part of their final examination. Only those dissertations and higher degree theses relating to East Midland subjects are listed below. ***Bona fide*** students or research workers may apply for permission to consult them in the Department.

1961

Ph.D.

The East Midlands industrial area. A regional study of industrial location. D. M. Smith.

Geographical aspects of the railway industry. B. J. Turton.

M.A.

Aspects of the economic and social geography of the Mansfield area. C. M. Law.

DISSERTATIONS

Trends in the bread-baking industry in the Nottingham area. Judy A. Boyson.

The Isle of Axholme. A study of a changing landscape. P. Butler.

Coal and iron in the Erewash area. M. E. Lynn.

The location of the malting industry in the East Midlands. M. J. Mauger.

CORRECTIONS

In the article entitled "Iron and Steel at Corby" by D. C. D. Pocock in *E.M.G.* No. 15 (June, 1961) :—

On p. 3, second paragraph, line 13; for "deposits" read "districts."

On p. 5, second paragraph, line 5; after "iron" insert "smelting."

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